1. You read in a journal a report of a study that found a statistically significant result at the 5% significance level. What can you say about the significance of this result at the 1% level?
   a. it is certainly not significant at the 1% level
   b. it may or may not be significant at the 1% level
   c. it certainly is significant at the 1% level

2. (True or false) In a test of significance, a P-value of 0.03 means that there is only probability 0.03 that the null hypothesis is true.

3. In a Risk Management Study on fires in compartmented fire-resistant buildings, the data below was generated. The data in the table give the number of victims who died trying to evacuate for a sample of 14 recent fires.

<table>
<thead>
<tr>
<th>FIRE</th>
<th>NUMBER OF VICTIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Las Vegas Hilton (Las Vegas)</td>
<td>5</td>
</tr>
<tr>
<td>Inn on the Park (Toronto)</td>
<td>5</td>
</tr>
<tr>
<td>Westchase Hilton (Houston)</td>
<td>8</td>
</tr>
<tr>
<td>Holiday Inn (Cambridge, Ohio)</td>
<td>10</td>
</tr>
<tr>
<td>Conrad Hilton (Chicago)</td>
<td>4</td>
</tr>
<tr>
<td>Providence College (Providence)</td>
<td>8</td>
</tr>
<tr>
<td>Baptist Towers (Atlanta)</td>
<td>7</td>
</tr>
<tr>
<td>Howard Johnson (New Orleans)</td>
<td>5</td>
</tr>
<tr>
<td>Cornell University (Ithaca)</td>
<td>9</td>
</tr>
<tr>
<td>Westport Central Apartments (Kansias City, MO)</td>
<td>4</td>
</tr>
<tr>
<td>Orrington Hotel (Evanston IL)</td>
<td>0</td>
</tr>
<tr>
<td>Hartford Hospital (Hartford, CT)</td>
<td>16</td>
</tr>
<tr>
<td>Milford Plaza (New York)</td>
<td>0</td>
</tr>
<tr>
<td>MGM Grand (Las Vegas)</td>
<td>36</td>
</tr>
</tbody>
</table>


   a. State the assumption, in terms of the problem, that is required for the confidence interval technique to be valid.

   b. Construct a 98% confidence interval for the true mean number of victims per fire who die attempting to evacuate compartmented fire-resistant buildings.

   c. Interpret the interval constructed in part b.

4. The calibration of a scale is to be checked by weighing a 10-kg test specimen 25 times. The results of different weighings are independent of one another; the sample standard deviation $s$ of the 25 weighings is $s = 0.20$ kg. Let $\mu$ denote the true average weight reading on the scale.
   a. What hypotheses should be tested?

   b. Suppose the rejection region is \{\bar{x} \geq 10.11188 \text{ or } \bar{x} \leq 9.88812\}. What is the value of $\alpha$ for this test?
c. What is \( \beta(10.1) \) that is, what is \( P(Type\ II\ error\ when\ \mu = 10.1) \)?
d. What is the power of the test against the alternative \( \mu = 10.1 \)?

5. A \( P \)-value is the probability:
   a. of committing a Type I error
   b. of committing a Type II error
   c. calculated assuming \( H_0 \) is true, that the test statistic would assume a value as or more extreme than the value stated in the null hypothesis
   d. calculated assuming \( H_0 \) is true, that the test statistic would assume a value as or more extreme than the observed value of the test statistic.
e. that \( H_0 \) is true.
f. that we have made a mistake, assuming \( H_0 \) is true

6. Which of the following statements is false?
   a. The \( t \) distribution is symmetric about zero
   b. The \( t \) distribution is more spread out than the standard normal distribution
   c. As the degrees of freedom get smaller, the \( t \)-distribution's dispersion gets smaller
   d. The \( t \) distribution is mound-shaped

7. The Student \( t \) distribution approaches the normal distribution as the:
   a. degrees of freedom increase
   b. degrees of freedom decrease
   c. sample size decreases
   d. population size increases

8. The statistic \( \frac{\overline{x} - \mu}{s/\sqrt{n}} \) has the student \( t \) distribution if the sample is selected from:
   a. a population that can be described by a Student \( t \) model
   b. a population that can be described by a normal model
   c. a negatively skewed distribution (skewed to the left)
   d. a positively skewed distribution (skewed to the right)

9. Domino's Pizza in Big Rapids, Michigan, advertises that they deliver your pizza within 15 minutes of placing an order or it is free. A sample of 25 customers is selected at random. The average delivery time in the sample was 13 minutes with a sample standard deviation of 4 minutes.
   a. Test to determine if we can infer at the 5% significance level that the population mean is less than 15 minutes.
   b. What is the required condition of the technique used in part (a)?
   c. Approximate the \( P \)-value for this test.

10. A marketing consultant was interested in estimating the mean weekly consumption of soft drinks among teenagers. A random sample of 61 teenagers were asked how many ounces of soft drink they consume daily. The sum of the observations and the sum of the squared observations are shown below.

\[
\sum_{i=1}^{61} x_i = 1365 \quad \text{and} \quad \sum_{i=1}^{61} (x_i - \overline{x})^2 = 1605.328
\]

Estimate with 99% confidence the mean daily consumption of soft drinks by teenagers.

11. Suppose that 9 observations are drawn from a population that is approximately symmetric and mound-shaped. The observations are:

15 9 13 11 8 12 11 7 10
12. The mean SAT mathematics score in Illinois is 450. The Chicago, Illinois school district instituted a new high school mathematics curriculum several years ago and as a result, the superintendent thinks the Chicago SAT math scores are above the state average. The superintendent samples 500 students and tests the hypotheses

\[ H_0 : \mu = 450 \]
\[ H_a : \mu > 450 \]

with \( \alpha = .01 \), where \( \mu \) is the mean SAT mathematics score of Chicago high school students. Historically the standard deviation of SAT math scores has been approximately 100. If the Chicago mean SAT math score is at least 10 points above the state average, the superintendent will receive a hefty pay raise from the school board.

a. What is the power of this test to an increase of 10 points in Chicago's mean SAT math score?

b. What is the power of this test to an increase of 10 points in Chicago's mean SAT math score if the sample size is 750?

13. As the sample size \( n \) increases, when the confidence level is held fixed the width of the confidence interval for the population mean tends to:

a. increase

b. decrease

c. stay the same

14. A random sample of size 49 was selected; the resulting sample standard deviation \( s = 7.829 \) Suppose the confidence interval formed for \( \mu \) was \( 63 < \mu < 69 \).

a. What is the sample mean, \( \bar{x} \)?

b. What is the standard error of \( \bar{x} \)?

c. What was the confidence coefficient used to form the confidence interval?

15. A confidence coefficient of 0.99 can correctly be interpreted to mean that

a. 99% of the time in repeated sampling, intervals using an appropriate formula will contain the sample value.

b. 99% of the time in repeated sampling, intervals using an appropriate formula will contain the relevant population parameter.

c. 99% of the time in repeated sampling, intervals using an appropriate formula will contain the sample value as the midpoint of the interval.

d. 99% of the time in repeated sampling, intervals using an appropriate formula will contain the sample mean as their midpoints.

16. Perform the hypothesis test shown below,

\[ H_0 : p = .05 \]
\[ H_a : p < .05 \]

given that a random sample of size 1000 revealed that the number of successes was 40. Compute the P-value and use it to make a conclusion concerning the hypothesis test.

17. A professor claims that 70% of College of Business graduates earn more than $45,000 per year. In a random sample of 300 graduates, 195 earn more than $45,000. Perform a hypothesis test to evaluate the professor's claim.

18. A random sample of 100 individuals was taken to determine the true percentage of people who smoke in a region of the eastern United States. Forty-six of them said “yes” when they were asked...
19. To test the hypotheses
   \[ H_0 : p = 0.06 \]
   \[ H_a : p < 0.06 , \]
a random sample of size 1000 revealed that the number of successes was 40. Compute the \( P \)-value and explain how to use it to test the hypothesis.

20. A candy company claims that in a large bag of St. Patrick's Day candy half the candies are green and half are white. You select candies at random from a bag and discover that of the first 50 you eat, only 15 are green. This makes you suspicious of the company's claim that half are green and half are white. Perform a hypothesis test to test the company's claim.

21. In the 1980's it was generally believed that congenital abnormalities affected about 5% of the nation's children. Some people believe that the increase in the number of chemicals in the environment has lead to an increase in the incidence of abnormalities. A recent study examined 408 children and found that 48 of them showed signs of an abnormality. Is this evidence that the risk has increased?
   i) Let \( p \) denote the proportion of children with genetic abnormalities. Choose the correct null and alternative hypotheses.
   A. \( H_0 : \hat{p} = 0.1176 \) vs \( H_A : \hat{p} > 0.1176 \)
   B. \( H_0 : \hat{p} = 0.05 \) vs \( H_A : \hat{p} > 0.05 \)
   C. \( H_0 : \hat{p} = 0.1176 \) vs \( H_A : \hat{p} = 0.05 \)
   D. \( H_0 : \hat{p} = 0.05 \) vs \( H_A : \hat{p} > 0.05 \)
   E. \( H_0 : \hat{p} = 0.05 \) vs \( H_A : \hat{p} < 0.05 \)
   F. \( H_0 : \hat{p} = 0.1176 \) vs \( H_A : \hat{p} < 0.1176 \)

   ii) What is the value of the test statistic?
   iii) What is the \( P \)-value?
   iv) What is your conclusion?

22. Recently there have been campaigns encouraging people to save energy by carpooling to work. Some cities have created “carpool only” traffic lanes (i.e. only cars with 2 or more passengers can use these lanes). In order to evaluate the effectiveness of carpool only lanes, toll booth personnel in one city monitor 2,000 randomly selected cars in 2005 before the carpool lanes were established and 1,500 cars in 2007 after the lanes were established. The results are shown below, where \( x_1 \) (\( x_2 \)) is the number of cars with 2 or more passengers in the data for 2007 (2005). Use a 95% confidence interval to determine whether the data indicate that the proportion of cars with carpool riders has increased over this period.
   \[
   \begin{align*}
   \text{year 2007: } n_1 &= 1,500, x_1 = 576; \\
   \text{year 2005: } n_2 &= 2,000, x_2 = 652.
   \end{align*}
   \]

23. When female undergraduates switch from science, mathematics, and engineering (SME) majors into disciplines that are not science-based, such as journalism, marketing, and sociology, are their reasons different from the reasons that male undergraduates have for switching from SME majors? At a large research university 335 junior/senior undergraduates (172 females and 163 males) were identified as “switchers” — that is, they left a declared SME major for a non-SME major. Thirty-three of the 172 females in the sample admitted that they were discouraged or lost confidence due to low grades in SME during their early years, compared to 44 of the 163 males.

Construct a 90% confidence interval for the difference between the proportions of female and male switchers who lost confidence due to low grades in SME. Interpret the result.

24. A marketing consultant for Burpsee Cola claims that teenagers consume on average at least 22 oz. of soft drinks per day. A random sample of 61 teenagers were asked how many ounces of soft drink they consume daily. The sample mean and sample standard deviation are, respectively, 22.38 and 5.17. Perform a hypothesis test of the marketing consultant's claim.
1. b. 2. False
3. a. The distribution of the population of the number of victims who attempt to evacuate fires can be described by a normal model.
   b. From the 14 observations, \( \bar{x} = 8.36, s = 8.94; \) confidence coefficient \( .98 \Rightarrow \alpha = .02, \) from the \( t \)-table, \( t_{0.02} = 2.650, \)
   \[
   \bar{x} \pm t_{0.01, 13} \left( \frac{s}{\sqrt{n}} \right) = 8.36 \pm 2.650 \left( \frac{8.94}{\sqrt{14}} \right) = 8.36 \pm 6.33 = (2.03, 14.69)
   \]
   c. “We are 98% confident that the interval (2.03, 14.69) encloses the true mean number of victims who die attempting to evacuate compartmented fire-resistant buildings.
4. a. \( H_0 : \mu = 10, H_a : \mu \neq 10; \)
   b. \( \alpha = P(\bar{x} \geq 10.11188 \) or \( \bar{x} \leq 9.88812 \) when \( \mu = 10) = P(t \geq 2.7969) \) or \( t \leq -2.7969) = .01 \)
   c. \( \beta(10.1) = P(9.88812 \leq \bar{x} \leq 10.11188 \) when \( \mu = 10.1) = P(-5.297 \leq z \leq .297) = .6168. \)
   d. Power when \( \mu = 10.1 = 1 - \beta(10.1) = 1 - .6168 = .3832 \)
5. d 6. c 7. a 8. b
9. a. \( H_0 : \mu = 15, H_a : \mu < 15; \) Rejection region: \( t < -t_{0.05, 24} = -1.711; \) Test statistic: \( t = -2.50; \)
   Conclusion: Reject the null hypothesis. Yes, we can conclude that the mean delivery time is less than 15 minutes.
9. b. The distribution of pizza delivery times can be described by a normally model.
9. c. Approximate \( P \)-value: the test statistic \( t = -2.5 \) is between \( t_{0.05, 24} = -2.492 \) and \( -t_{0.05, 24} = -2.797 \). The \( P \)-value is between .005 and .01 (TI83: \( P \)-value = .0098)
10. a. \( H_0 : \mu = 10, H_a : \mu \neq 10; \)
    b. \( t = \frac{10.67 - 10}{.804} = .804 \)
    c. \( P \)-value = \( 2P(\mid t \mid > .804) = 2(2223) = .4446. \)
11. a. \( H_0 : \mu = 10, H_a : \mu \neq 10; \)
   b. \( t = \frac{10.67 - 10}{.804} = .804 \)
   c. \( P \)-value = \( 2P(\mid t \mid > .804) = 2(2223) = .4446. \)
   d. Do not reject \( H_0; \) there is no evidence that \( \mu \) differs from 10.
12. a. Calculate the POWER of the test when \( \mu = 460 \) (the probability the test will reject \( H_0 \) when \( \mu = 460 \)).
   STEP 1: calculate the rejection region in terms of \( \bar{x} \).
   Since \( \alpha = .01, \) the RR is \( z > 2.33; \) in terms of \( \bar{x} \) this is equivalent to the inequality
   \[
   \frac{\bar{x} - 450}{100/\sqrt{500}} > 2.33
   \]
   which implies \( \bar{x} > 450 + 2.33\left(\frac{100}{\sqrt{500}}\right) = 460.42. \) So we will reject \( H_0 \) when \( \bar{x} > 460.42. \)
   STEP 2: Calculate the power when \( \mu = 460. \)
   \[
   P(\bar{x} > 460.42 \text{ when } \mu = 460) = P\left(\frac{\bar{x} - 460}{100/\sqrt{500}} > \frac{460.42 - 460}{100/\sqrt{500}}\right) = P(z > .094) = \frac{.463}{2}
   \]
   b. If the sample size is \( n = 750, \) the rejection region in terms of \( \bar{x} \) is
   \[
   \frac{\bar{x} - 450}{100/\sqrt{750}} > 2.33
   \]
   which implies \( \bar{x} > 450 + 2.33\left(\frac{100}{\sqrt{750}}\right) = 458.51. \)
   The power when \( \mu = 460 \) is
\[ P(\bar{x} > 458.51 \text{ when } \mu = 460) = P \left( \frac{\bar{x} - 460}{100/\sqrt{750}} > \frac{458.51 - 460}{100/\sqrt{750}} \right) \]
\[ = P(z > -0.41) \]
\[ = 0.659 \]

13. b  \( \frac{63 + 63}{2} = 66 \)  b. \( SE(\bar{x}) = \frac{s}{\sqrt{n}} = \frac{7.820}{\sqrt{49}} = 1.118 \)  c. \( t_{45} \frac{s}{\sqrt{n}} = 3 \Rightarrow t_{45} = 2.683 \) so confidence level is approx. 99%. 15. b.

16. test statistic \( z = -1.451 \); P-value = \( P(z < -1.451) = .0734 \). Since the P-value is greater than \( \alpha = .05 \), do not reject \( H_0 \); there is no evidence that \( p \) differs significantly from .5.

17. \( H_0 : p = .7, H_a : p \neq .7; \hat{p} = \frac{185}{200} = .65 \); test statistic \( z = \frac{.65 - .7}{\sqrt{\frac{.7 \times .3}{200}}} = -1.89 \); P-value = \( P(z < -1.89) + P(z > 1.89) = .0588 \). Since P-value > .05, do not reject the null hypothesis; there is no evidence that \( p \) differs significantly from .7.

18. d

19. \( \hat{p} = \frac{40}{1090} = .04 \); test statistic \( z = \frac{.04 - .06}{\sqrt{\frac{.04 \times .96}{1090}}} = -2.66 \); P-value = \( P(z < -2.66) = .00387 \).

Since the P-value is less than .05, reject \( H_0 \) and conclude that there is sufficient evidence to reject the null hypothesis \( H_0 : p = .06 \) in favor of \( H_A : p < .06 \).

20. \( H_0 : p = .5, H_A : p < .5 \), where \( p \) is the proportion of candies that are green.

\( \hat{p} = \frac{10}{50} = .30 \); \( SD(\hat{p}) = \sqrt{\frac{(0.5)(1-0.5)}{50}} = \sqrt{\frac{25}{50}} = .005 = .0707 \);

test statistic: \( z = \frac{.30 - .50}{.005} = -2.83 \);

P-value: \( P(z < -2.83) = .0023 \);

Conclusion: since the P-value is less than .05, we reject the null hypothesis \( H_0 : p = .5 \) and conclude that the proportion green candies is less than .5.

21. i) D  ii) \( \hat{p} = \frac{48}{4808} = 0.1176 \); \( SD(\hat{p}) = \sqrt{\frac{(0.05)(1-0.05)}{4808}} = \sqrt{\frac{20475}{4808}} = .003 \);

\( z = \frac{0.1176 - 0.05}{0.003} = 22.53 \);

iii) P-value: \( P(z > 22.53) \approx 0 \); iv) Since the P-value is almost zero, there is strong evidence against the null hypothesis \( H_0 : p = .05 \); we reject \( H_0 : p = .05 \) and conclude that the risk has increased.

22. 2007: \( \hat{p} = \frac{576}{1300} = .384 \); 2005: \( \hat{p} = \frac{652}{2006} = .326 \);

\( (.384 - .326) \pm 1.96 \sqrt{\frac{(0.384)(1-0.384)}{1300} + \frac{(0.326)(1-0.326)}{2006}} = .058 \pm .032 \Rightarrow (.026, .09) \);

Conclusion: Since the interval is entirely positive, conclude that the proportion of all cars with carpool riders is greater in 2007 than in 2005.

23. females: \( \hat{p}_{females} = \frac{23}{172} = .1919 \); males: \( \hat{p}_{males} = \frac{44}{163} = .2699 \);

\( (.1919 - .2699) \pm 1.645 \sqrt{\frac{(0.1919)(0.8081)}{172} + \frac{(0.2699)(0.7301)}{163}} = -.078 \pm .076 \Rightarrow (-.154, -.002) \);

Conclusion: Since the interval is entirely negative, conclude that the proportion of male switchers that switch because of lost confidence due to low grades is greater than the proportion of female switchers that switch because of lost confidence due to low grades.

24. \( H_0 : \mu = 22, H_A : \mu > 22 \), where \( \mu \) is the mean daily amount of soft drinks (in ounces) consumed by teenagers.

test statistic: \( t = \frac{22.38 - 22}{4.63} = 0.574 \);

P-value: in the df = 60 row, the test statistic \( t = 0.574 \) is between 0.3872 and 0.6786; the area to the right of 0.3872 is 0.35; the area to the right of 0.6786 is 0.25. Therefore the lower bound on the P-value is 0.25, the upper bound on the P-value is 0.35. 0.25 \( \leq P-value \leq 0.35 \).

Conclusion: since the P-value is greater than .05, we do not reject \( H_0; \mu = 22 \); there is no evidence that teenagers drink more than 22 oz. of soft drinks per day on average.