You are permitted to use a calculator on all portions of this test. You are not allowed to use any textbook, notes, cell phone, or laptop on any portion of this test. All devices must be turned off while you are in the testing room.

During this test, any communication with any person (other than the instructor or test proctor) in any form, including written, signed, verbal, or digital, is understood to be a violation of academic integrity.

No part of this test may be removed from the testing room.

Read each question very carefully. In order to receive full credit for the free response portion of the test, you must:

1. Show legible and logical (relevant) justification which supports your final answer.
2. Use complete and correct mathematical notation.
3. Include proper units, if necessary.

You have 90 minutes to complete the entire test.

On my honor, I have neither given nor received inappropriate or unauthorized information at any time before or during this test.

Student’s Signature: ________________________________________________

Do not write below this line.

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Part I: Multiple Choice. There are 20 multiple choice questions. Solve each question using the available space for scratch work. Decide which is the best of the choices given and fill in the corresponding oval on the provided scantron using a #2 pencil. For your own record, also circle your choice on your test since the scantron will not be returned to you. Only the responses recorded on your scantron sheet will be graded. Each multiple choice question is worth 3 points.

1. In a Gallup Poll, 354 of 600 adults surveyed said they want to lose weight. Which of the following expressions gives a 90% confidence interval for the proportion of people in the population that want to lose weight?

   (A) $0.59 \pm 1.645 \sqrt{\frac{(0.59)(0.41)}{354}}$

   (B) $0.59 \pm 1.645 \sqrt{\frac{(0.59)(0.41)}{600}}$

   (C) $0.59 \pm 1.96 \sqrt{\frac{(0.59)(0.41)}{354}}$

   (D) $0.59 \pm 1.96 \sqrt{\frac{(0.59)(0.41)}{600}}$

2. A polling agency wants to estimate the percentage of voters in favor of extending tax cuts, and it wants to provide a margin of error of no more than 1.8 percentage points. Using 95% confidence, how many respondents must the agency poll?

   (A) Cannot be determined from the given information.

   (B) 30

   (C) 564

   (D) 2965
3. The figure below displays a histogram and a boxplot of the monthly cell phone bill for a random sample of 50 college students.

Would it be appropriate to use this sample data to construct a $t$-interval for the mean monthly cell phone bill of all college students?

(A) No, because the sample data are skewed right.
(B) No, because the sample size is more than 5% of the population size.
(C) Yes, because the data come from a random sample, the sample size is less than 5% of the population size, and $n \geq 30$.
(D) Yes, because the data come from a random sample, the sample size is less than 5% of the population size, and $np(1 - p) \geq 10$.

4. A sample size of 16 was used to test the hypotheses $H_0: \mu = 100$ versus $H_1: \mu > 100$. The calculated value of the test statistic was 2.241. Into what range does the $p$-value for this test fall?

(A) $0.01 < p$-value < 0.02
(B) $0.02 < p$-value < 0.025
(C) $0.04 < p$-value < 0.05
(D) $0.05 < p$-value < 0.10
Use the following information to answer questions 5 – 6.
Clemson's Career Center surveyed a random sample of students who graduated from Clemson University the previous year to determine if they were still looking for a job. The survey included 125 science majors, of which 15 were still looking for a job. Of the 150 non-science majors who were surveyed, 12 were still looking for a job.

5. Which of the following gives the hypotheses in a hypothesis test to see if there is a larger proportion of science (S) majors still looking for a job compared to non-science (NS) majors?

(A) \( H_0: \hat{p}_S = \hat{p}_{NS} \)
\( H_1: \hat{p}_S > \hat{p}_{NS} \)

(B) \( H_0: \hat{p}_S > \hat{p}_{NS} \)
\( H_1: \hat{p}_S = \hat{p}_{NS} \)

(C) \( H_0: p_S = p_{NS} \)
\( H_1: p_S > p_{NS} \)

(D) \( H_0: p_S > p_{NS} \)
\( H_1: p_S = p_{NS} \)

6. Which of the following expressions gives the test statistic for this hypothesis test?

(A) \( \frac{.12 - .08}{.08(.92)} \)
\( \sqrt{\frac{1}{150}} \)

(B) \( \frac{.08 - .12}{.12(.88)} \)
\( \sqrt{\frac{1}{125}} \)

(C) \( \frac{.12 - .08}{.12(.88) + .08(.92)} \)
\( \sqrt{\frac{1}{125} + \frac{1}{150}} \)

(D) \( \sqrt{\frac{27}{275}(1 - \frac{27}{275}) + \frac{1}{125} + \frac{1}{150}} \)

\( \frac{.12 - .08}{.08(.92)} \)
Use the following information to answer questions 7 – 9.
Citizens in a growing community would like to build a school that would be more convenient for their children to attend. They are proposing a 1 cent per dollar sales tax increase to pay for the school. They want the proposed sales tax increase to be submitted as a referendum in the upcoming county elections where a majority of yes votes would make the proposal law. A local journalist conducted a survey to see if the proposal would pass if placed on the ballot. She randomly selected 650 voters from the list of registered voters; 364 of these are in favor of the sales tax increase to fund construction of the school.

7. What population parameter is the journalist interested in testing?
   (A) The true mean sales tax increase that voters would approve.
   (B) The true proportion of county citizens who are registered voters.
   (C) The true proportion of registered voters who would vote yes on a sales tax increase.
   (D) The true proportion of survey respondents who were in favor of a sales tax increase.

8. Which of the following expressions gives the test statistic for the journalist's hypothesis test?
   (A) \[ \frac{.50 - .56}{\sqrt{.50(.50)/650}} \]
   (B) \[ \frac{.50 - .56}{\sqrt{.56(.44)/650}} \]
   (C) \[ \frac{.56 - .50}{\sqrt{.50(.50)/650}} \]
   (D) \[ \frac{.56 - .50}{\sqrt{.56(.44)/650}} \]

9. Which of the following best describes a Type II Error for this hypothesis test?
   (A) Concluding that a majority of voters favor the sales tax increase when a majority of voters does not favor the proposal.
   (B) Concluding that a minority of voters favor the sales tax increase when a minority of voters does not favor the proposal.
   (C) Failing to conclude that a majority of voters favor the sales tax increase when a majority of voters actually does favor the proposal.
   (D) Failing to conclude that a minority of voters favor the sales tax increase when a minority of voters actually does favor the proposal.
Use the following information to answer questions 10 – 11.
Based on a random sample of 1200 adults, a 95% confidence interval for the proportion of all adults who regularly wear a wrist watch is (0.29, 0.35).

10. What is the point estimate for the proportion of all adults who regularly wear a wrist watch based on these sample results?
   (A) 0.03
   (B) 0.32
   (C) 0.33
   (D) Cannot be determined from the given information.

11. Which of the following gives the best interpretation of this confidence interval?
   (A) Approximately 95% of all possible samples of 1200 adults will result in a sample proportion of adults who regularly wear a wrist watch between 0.29 and 0.35.
   (B) There is a 95% chance that the proportion of all adults who regularly wear a wrist watch is between 0.29 and 0.35.
   (C) We are 95% confident that the sample proportion of adults who regularly wear a wrist watch is between 0.29 and 0.35.
   (D) We are 95% confident that the proportion of all adults who regularly wear a wrist watch is between 0.29 and 0.35.

12. Recall that if a criminal trial is viewed as a hypothesis test, the hypotheses are

   \[ H_0: \text{The defendant is innocent} \]
   \[ H_1: \text{The defendant is guilty}. \]

   A defense attorney argues that for death penalty cases, the standard of evidence for conviction should be strengthened from 'beyond a reasonable doubt' to 'beyond any doubt.' He believes that for death penalty cases…

   (A) The value of \( \alpha \) used should be close to 0.
   (B) The value of \( \beta \) used should be close to 0.
   (C) The courts commit too many Type II errors.
   (D) The courts should render more verdicts of innocent.
13. A consumer group wishes to test Apple's claim that the iPad has a 10-hour battery life. After running a random sample of 15 iPads under identical conditions, the group finds a 99% confidence interval for the mean battery life of an iPad to be (8.45, 10.05) hours. Assuming battery life of an iPad is approximately normally distributed, does this confidence interval provide evidence that the iPad does not have an average battery life of 10 hours?

(A) No, because the 99% confidence interval contains 10 hours.

(B) Yes, because 10 is near the upper endpoint of the confidence interval and the majority of the plausible values for the mean battery life of an iPad are less than 10 hours.

(C) Yes, because if a 95% confidence interval for the true mean battery life were constructed it most likely would not contain 10 hours.

(D) The sample size is not large enough to make a conclusion about the mean battery life of an iPad.

14. Based on a random sample of 45 women, a 90% confidence interval for the population mean pulse rate of women is (69.2, 77.8) beats per minute. How would this confidence interval change if the sample results were instead based on a sample of 450 women, assuming that nothing else changes?

(A) The confidence interval based on 450 women would be wider.

(B) The confidence interval based on 450 women would be narrower.

(C) The confidence interval based on 450 women would be the same width.

(D) Cannot be determined from the given information.

15. A researcher conducts a two sample t-test in order to test the following hypotheses:

\[ H_0: \mu_A = \mu_B \]
\[ H_1: \mu_A > \mu_B \]

She finds that the \( p \)-value is .075. Her colleague wishes to conduct the same hypothesis test, but will change his alternative hypothesis to \( \mu_A \neq \mu_B \) and will use \( \alpha = .10 \). What can be said about the results of his test?

(A) He will reject the null hypothesis.

(B) He will fail to reject the null hypothesis.

(C) There is not enough information provided to determine the results of his test.

(D) Whether he rejects the null hypothesis depends on the brand of statistical software he uses.
16. The JMP output below shows the results from constructing 100 different confidence intervals of the same confidence level, each based on a different sample of size $n = 75$ from a population in which the population proportion is $p = 0.8$.

Based on these results, what is the most likely value of the confidence level used in constructing these confidence intervals?

(A) 80%
(B) 90%
(C) 99%
(D) 100%

17. A 95% confidence interval for $\mu_A - \mu_B$ is given by $(-2.3, 4.5)$. What can we infer from this confidence interval?

(A) This confidence interval implies that the mean for sample A is less than the mean for sample B.
(B) This confidence interval implies that the mean for population A is less than the mean for population B.
(C) This confidence interval implies that the mean for population A is greater than the mean for population B.
(D) This confidence interval implies that there is not a significant difference between the mean for population A and the mean for population B.
18. When testing the hypotheses $H_0: \mu = 18$ versus $H_1: \mu < 18$, a $p$-value of .545 was obtained. Which of the following statements must be true?

(A) The population mean is less than 18.
(B) The population mean is greater than 18.
(C) The sample mean is less than 18.
(D) The sample mean is greater than 18.

Use the following information to answer questions 19 – 20.

Researchers in education are performing a study to see if listening to soothing music while taking a standardized math test increases the mean test score. The hypotheses are $H_0: \mu = 79$ versus $H_1: \mu > 79$, and the $p$-value for the hypothesis test was .035.

19. Which of the following is the best interpretation of this $p$-value?

(A) If listening to soothing music has no effect on the mean test score, the probability of obtaining the observed mean test score or something larger is .035.
(B) If listening to soothing music increases the mean test score, the probability of obtaining the observed mean test score or something larger is .035.
(C) There is a 3.5% chance that listening to soothing music has no effect on the mean test score.
(D) There is a 3.5% chance that listening to soothing music increases the mean test score.

20. At the 5% significance level, what should the researchers conclude?

(A) There is sufficient evidence to conclude that listening to soothing music increases the mean test score.
(B) There is sufficient evidence to conclude that listening to soothing music decreases the mean test score.
(C) There is insufficient evidence to conclude that listening to soothing music increases the mean test score.
(D) None of the above.
Part II: Free Response. Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations. Answers with no justification will receive no credit.

1. A random sample of 35 public four-year colleges in 2014-2015 had a mean tuition for in-state students of $9140, with a standard deviation of $2160.

   (a) What conditions would need to be met in order to construct a confidence interval for the mean 2014-2015 tuition for in-state students at all public four-year colleges? Are these conditions met? Justify your answers. (3 pts)
   1. Random sample – stated in problem
   2. \( n = 35 \) is likely less than 5% of all public four-year colleges
   3. \( n = 35 \geq 30 \)

   1 pt for each condition correctly stated AND checked
   Subtract 1 pt if additional incorrect conditions listed

   (b) Calculate a 99% confidence interval for the mean 2014-2015 tuition for in-state students at all public four-year colleges. Round your final answer to two decimal places. (4 pts)

   \[
   x_\bar \pm t_{\alpha/2} \left( \frac{s}{\sqrt{n}} \right)
   \]

   \[
   = 9140 \pm 2.728 \left( \frac{2160}{\sqrt{35}} \right)
   \]

   \[
   \approx 9140 \pm 2.728(365.10664)
   \]

   \[
   \approx 9140 \pm 996.01091
   \]

   \[
   \approx ($8,143.99, $10,136.01)
   \]

   2 pts for finding the correct critical value
   1 pt for correctly substituting values into the CI formula
   1 pt for the correct final answer

   (c) Interpret the interval you found in part (b). (2 pts)

   We are 99% confident that the true mean 2014-2015 tuition for in-state students at public four-year colleges is between $8,143.99 and $10,136.01.

   1 pt for stating we are 99% confident (not chance, probability, etc.)
   1 pt for describing parameter in context (including referencing the population)
   AND giving the endpoints of the interval

   No credit awarded for an incorrect interpretation
2. It is known that 27% of Americans suffered from credit card information theft in the twelve months prior to October 2014. In October of 2015, 249 out of 1015 randomly selected Americans polled by Gallup reported being the victim of credit card information theft in the last twelve months. Is this evidence that the rate of this crime has decreased compared to last year? Test at the $\alpha = .01$ significance level.

(a) Define the parameter of interest and state the null and alternative hypotheses. (3 pts)

Let $p =$ the proportion of all Americans that were the victim of credit card theft in the twelve months prior to October 2015.

$H_0: p = 0.27$

$H_1: p < 0.27$

1 pt for correctly defining the parameter of interest
1 pt for using equals sign in $H_0$ and less than sign in $H_1$
1 pt for using the correct value in the hypotheses

Note: In order to earn the point for correctly defining the parameter, the correct symbol must be used and the definition must reference the population.

(b) Check that the conditions necessary for a hypothesis test have been met. (3 pts)

1. Random sample – stated in problem
2. $n = 1015$ is less than 5% of all Americans
3. $np_0(1 - p_0) = 1015(0.27)(0.73) \approx 200 \geq 10$

1 pt for each condition correctly stated AND checked
Subtract 1 pt if additional incorrect conditions listed

(c) Calculate the test statistic. (2 pts)

$$z_0 = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}} = \frac{\frac{249}{1015} - 0.27}{\sqrt{\frac{(0.27)(0.73)}{1015}}} \approx -1.77$$

1 pt for correctly filling in formula
1 pt for correct final answer

(d) Determine the $p$-value. (1 pt)

$p$-value = $P(Z < -1.77) = 0.0384$

1 pt for correct $p$-value given $H_1$ and $z_0$

(e) Write a conclusion for this hypothesis test. (3 pts)

Do not reject $H_0$ because the $p$-value of 0.0384 is greater than $\alpha = .01$. At the 1% significance level, there is insufficient evidence to conclude that the rate of credit card information theft has decreased compared to last year.
3. A survey was conducted to see if there is a difference in support of college football programs depending on location of residents in South Carolina. The survey included 1,200 randomly selected people living in the upstate of South Carolina, and when asked if they believe Clemson would beat the University of South Carolina in the upcoming football game this season, 1068 said Clemson would win. When 1,500 randomly selected people living in the low-country of South Carolina were asked the same question, 1275 said Clemson would win.

(a) Assume that all conditions necessary for inference have been checked and verified. Construct a 95% confidence interval for the difference in the proportion of upstate and low-country South Carolina residents that believe Clemson will beat the University of South Carolina in the upcoming college football game. Round your final answer to three decimal places. (4pts)

Let \( p_U \) = the true proportion of upstate residents who believe Clemson will beat USC 
& \( p_{LC} \) = the true proportion of low-country residents who believe Clemson will beat USC

\[
\hat{p}_U = \frac{1068}{1200} = 0.89, \quad \hat{p}_{LC} = \frac{1275}{1500} = 0.85
\]

95% CI for \( p_U - p_{LC} \):

\[
(\hat{p}_U - \hat{p}_{LC}) \pm z_{\alpha/2} \sqrt{\frac{\hat{p}_U (1 - \hat{p}_U)}{n_U} + \frac{\hat{p}_{LC} (1 - \hat{p}_{LC})}{n_{LC}}}
\]

\[
= (0.89 - 0.85) \pm 1.96 \sqrt{\frac{0.89(0.11)}{1200} + \frac{0.85(0.15)}{1500}}
\]

\[
\approx 0.04 \pm 1.96(0.01291)
\]

\[
\approx 0.04 \pm 0.02530
\]

\[
\approx (0.015, 0.065)
\]

Note: The 95% CI for \( p_{LC} - p_U \) is \((-0.065, -0.015)\).

(b) Based on the confidence interval you found in part (a), is there a statistically significant difference in the proportion of upstate and low-country South Carolina residents that believe Clemson will beat the University of South Carolina? Explain. (2pts)

Yes, because all the values in the confidence interval are positive we can infer that a larger proportion of upstate residents believe Clemson will beat the University of South Carolina than low-country residents.

1 pt for correct decision based on CI from part (a)
1 pt for correct justification consistent with decision made
4. Adult female harpy eagles are thought to be larger than their male counterparts. In order to test this claim, a biologist randomly selects 8 female and 9 male adult harpy eagles and records their weights. The JMP output from her analysis is given below.
(a) Define the parameters and state the hypotheses that were tested. (3 pts)

Let $\mu_F$ = true mean weight of adult female harpy eagles
& $\mu_M$ = true mean weight of adult male harpy eagles

$H_0$: $\mu_F = \mu_M$
$H_1$: $\mu_F > \mu_M$

OR

$H_0$: $\mu_F - \mu_M = 0$
$H_1$: $\mu_F - \mu_M > 0$

Note: In order to earn the points for correctly defining the parameters, the correct symbols must be used and the definitions must reference the population.

(b) Check that the conditions necessary for a hypothesis test have been met. When necessary, refer to the JMP output on the previous page. (3 pts)

1. Independent random samples – stated in problem

2. $n_F = 8$ is likely less than 5% of all adult female harpy eagles
   $n_M = 9$ is likely less than 5% of all adult male harpy eagles

3. The normal probability plots for female weights and male weights indicate that the data could have come from populations that are approximately normal as they are both roughly linear.

(c) Use the JMP output on the previous page to report the test statistic, the degrees of freedom, and the $p$-value for this hypothesis test. (3 pts)

Test statistic: $2.698097$

$df$: $11.05961$

$p$-value: $.0103$

(d) Using $\alpha = .05$, state the conclusion in the context of the problem. (3 pts)

Reject $H_0$ because the $p$-value of $.0103$ is less than $\alpha = .05$. There is sufficient evidence to conclude that adult female harpy eagles are larger, on average, than their male counterparts.

1 pt for correctly defining the two population means
1 pt for setting the parameters equal in $H_0$
1 pt for the correct relationship in $H_1$

Subtract 1 pt if additional incorrect conditions listed

1 pt for each condition correctly stated AND checked
Subtract 1 pt if additional incorrect conditions listed

1 pt for each value correctly identified

1 pt for the correct decision about $H_0$ given $p$-value from part (c)
1 pt for justifying decision by comparing $p$-value to $\alpha$
1 pt for stating conclusion in terms of $H_1$ in context

Subtract 1 pt for language equivalent to accepting $H_0$ or accepting $H_1$

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Did you correctly fill in your scantron? (1 pt)

☐ Did you write your name, lecture section #, and lecture instructor at the top of the form?
☐ Did you fill in your CUID with the C bubbled as a 0?
☐ Did you bubble in your Test Version?
☐ Are your bubbles filled in dark enough so that the form can be machine read?