Read each question very carefully. You are permitted to use a calculator on all portions of this exam. You are NOT allowed to use any textbook, notes, cellphone, or laptop on either portion of the exam. No part of this exam may be removed from the examination room.

In order to receive full credit for the free response portion of the exam, 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 1 hour 30 minutes to complete the entire exam.

On my honor, I have neither given nor received inappropriate or unauthorized information during this exam.

Student’s Signature: ____________________________________________

Do not write below this line.

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Multiple Choice: (Questions 1 - 20) Answer the following questions on the scantron provided using a #2 pencil. Bubble the response that best answers the question. Each multiple choice correct response is worth 3 points. For your record, also circle your choice on your exam since the scantron will not be returned to you. Only the responses recorded on your scantron will be graded.

1. A research company desires to know the mean consumption of beef per week among males over age 43. They believe that beef consumption has a mean of 3.2 lb. Assume the standard deviation is known to be 1.3. How large of a sample would be required in order to estimate the mean weekly consumption of beef by males over age 43 at the 99% confidence level with an error of at most 0.09 lb.? (Round your answer up to the next integer)
   A. 37
   B. 1384
   C. 2137
   D. 802

2. A bolt manufacturer is very concerned about the consistency with which his machines produce bolts. The bolts should be 0.23 centimeters in diameter. The variance of the bolts should be 0.02. A random sample of 26 bolts has an average diameter of 0.22 cm with a standard deviation of 0.0828. What is the appropriate test statistic to determine if the manufacturer can conclude that the bolts vary from the required variance at $\alpha = 0.05$ level?
   A. $\chi^2 = \frac{25(0.0828^2)}{0.02^2}$
   B. $\chi^2 = \frac{26(0.0828^2)}{0.02}$
   C. $\chi^2 = \frac{25(0.02)}{0.0828^2}$
   D. $\chi^2 = \frac{25(0.0828^2)}{0.02}$

3. A newsletter publisher believes that above 22% of their readership own a personal computer. A random sample of 250 found that 29% of the readers owned a personal computer. What are the conditions needed to perform an appropriate hypothesis test to determine if there is sufficient evidence at the 0.01 level to substantiate the publisher’s claim.
   I. Population is normally distributed
   II. Sample size is larger than 30
   III. Random Sample from the population
   IV. $np \geq 5$ and $n(1-p) \geq 5$
   A. III and IV only
   B. I and III only
   C. II and III
   D. I, II, and III
4. Our environment is very sensitive to the amount of ozone in the upper atmosphere. The level of ozone normally found is 7.7 parts/million (ppm). A researcher believes that the current ozone level is not at the normal level. The mean of a random sample of 14 atmosphere measurements is 7.5 ppm with a standard deviation of 1.1. The 95% confidence interval for this sample is (6.86 ppm, 8.14 ppm). Based on this interval estimate does it appear that 7.7 ppm is a reasonable value for the population mean ozone level?

A. Yes, because 7.7 ppm lies within the interval
B. No, because 7.7 lies within the interval
C. Yes, because 7.5 lies within the interval
D. No, because 7.5 lies within in the interval.

5. A drug, which is used for treating cancer, has potentially dangerous side effects if it is taken in doses which are larger than the required dosage for the treatment. The tablet should contain 54.52 mg and the variance should be 0.01. 15 tablets are randomly selected and the amount of drug in each tablet is measured. The sample has a mean of 54.525 mg and a variance of 0.0007 mg. What type of test is appropriate to determine if the data suggest at \( \alpha = 0.01 \) that the tablets vary by less than the desired amount?

A. One sample t-test for mean
B. One sample proportion test
C. One sample test for variance

6. Noise levels at 6 randomly selected airports were measured in decibels yielding the following data: 144, 119, 140, 143, 128, 112

Construct the 99% confidence interval for the mean noise level at such locations. Assume the population is normally distributed. \(( \bar{x} = 131, s = 13.476)\)

A. \(131 \pm 2.576(13.476)\)
B. \(131 \pm 2.576(13.476/\sqrt{6})\)
C. \(131 \pm 4.032(13.476/\sqrt{6})\)
D. \(131 \pm 4.032(13.476)\)

7. A lumber company is making doors that are 2058.0 millimeters tall. If the doors are too long they must be trimmed, and if the doors are too short they cannot be used. A random sample of 25 doors is taken, and it is found that they have a mean of 2045.0 millimeters with a standard deviation of 20.0. A level of significance of 0.1 will be used to determine if the doors are either too long or too short. Find the value of the test statistic. Assume the population is normally distributed.

A. \(t = \frac{(2045 - 2058)}{20/\sqrt{25}}\)
B. \(t = \frac{(2045 - 2058)}{20/\sqrt{24}}\)
C. \(t = \frac{(2058 - 2045)}{20/\sqrt{25}}\)
D. \(t = \frac{(2058 - 2045)}{\sqrt{20/25}}\)
8. The mayor of a town believes that 54% of the residents favor annexation of an adjoining community. A random sample of 1000 voters showed that 51% of the residents favored annexation. What is the population of interest for a test to determine if there is sufficient evidence at the 0.01 level to refute the mayor's claim?

A. All 1000 voters
B. The voters of the 1000 sampled that favored annexation in this town
C. All voters in this town
D. The voters in the town that favor annexation

9. A newsletter publisher believes that 42% of their readership own a personal computer. A random sample of 120 found that 32% of the readers owned a personal computer. What is the appropriate test statistic to determine if there is sufficient evidence at the 0.10 level to refute the publisher's claim?

A. \( z = \frac{0.32 - 0.42}{\sqrt{\frac{0.42(1-0.42)}{120}}} \)
B. \( z = \frac{0.32 - 0.42}{\sqrt{\frac{0.42(1-0.42)}{120}}} \)
C. \( t = \frac{0.32 - 0.42}{\sqrt{\frac{0.42(1-0.42)}{120}}} \)
D. \( z = \frac{0.42 - 0.32}{\sqrt{\frac{0.42(1-0.42)}{120}}} \)

10. A newsletter publisher believes that above 22% of their readership own a personal computer. A random sample of 250 found that 30% of the readers owned a personal computer. What is the p-value to determine if there is sufficient evidence at the 0.01 level to substantiate the publisher's claim?

A. 0.220
B. 0.290
C. 0.001
D. 0.999
E. 0.002

11. A manufacturer of chocolate chips would like to know whether its bag filling machine works correctly at the 438 gram setting. Based on a random sample of 20 bags where the mean is 440 grams and the standard deviation is 11, a hypothesis test is performed to determine if there is sufficient evidence at the 0.05 level that the population mean weight of bags is different from 438. What is the appropriate rejection region (values of the test statistic that would reject the null hypothesis) of the hypothesis test that is performed?

A. Test statistic values less than -1.96 or greater than 1.96
B. Test statistic values less than -2.576 or greater than 2.576
C. Test statistic values less than –2.093 or greater than 2.093
D. Test statistic values less than -1.729 or greater than 1.729
E. Test statistic values less than -3.131 or greater than 3.131
12. The state education commission wants to estimate the fraction of tenth grade students that have reading skills at or below the eighth grade level. In an earlier study, the population proportion was estimated to be 0.16. How large a sample would be required in order to estimate the fraction of tenth graders reading at or below the eighth grade level at the 95% confidence level with an error of at most 0.03? (Round your answer up to the next integer)

A. 9  
B. 78  
C. 405  
D. 574

13. A quality-conscious disk manufacturer wishes to know the fraction of disks his company makes which are defective. Suppose a random sample of 1350 floppy disks is drawn. Of these disks, 1283 were defective. Using the data, construct the margin of error for the 95% confidence interval for the population proportion of disks which are defective.

A. \( (1.96) \sqrt{\frac{0.95(0.05)}{1350}} \)  
B. \( (1.96) \sqrt{\frac{0.95(0.05)}{1350}} \)  
C. \( \sqrt{1.96} \left( \frac{0.95(0.05)}{1350} \right) \)  
D. \( (1.96) \left( \frac{0.95(0.05)}{\sqrt{1350}} \right) \)  
E. Cannot determine because there is no standard deviation given

14. A newsletter publisher believes that more than 46% of their readership own a Rolls Royce. A random sample of 330 found that 50% of the readers owned a Rolls Royce. For a test to determine if there is sufficient evidence at the 0.05 level to substantiate the publisher's claim, what is the probability of a type I error?

A. 0.95  
B. 0.50  
C. 0.46  
D. 0.05  
E. Cannot be determined from information given

15. Find the value of \( t \) such that the area to the left of \(-t\) plus the area to the right of \( t \) equals 0.05. Assume the degrees of freedom equals 4.

A. 2.353  
B. 2.132  
C. 2.776  
D. 3.182
16. A drug, which is used for treating cancer, has potentially dangerous side effects if it is taken in doses which are larger than the required dosage for the treatment. The tablet should contain 54.52 mg and the variance should be 0.01. 15 tablets are randomly selected and the amount of drug in each tablet is measured. The sample has a mean of 54.525 mg and a variance of 0.0007 mg. What is the appropriate rejection region (values of the test statistic that would reject the null hypothesis)) to determine if the data suggests at $\alpha = 0.01$ that the tablets vary by less than the desired amount?

A. Test statistic values less than -2.576  
B. Test statistic values less than -4.66  
C. Test statistic values less than 4.66  
D. Test statistic values less than 5.229  
E. Test statistic values less than -2.624

17. A one-sample t-test for mean is performed. The test results in a p-value less than the significance level. This would imply….

A. The test statistic falls outside the rejection region therefore we fail to reject the null hypothesis  
B. The test statistic falls within the rejection region therefore we reject the null hypothesis  
C. The test statistic falls outside of the rejection region therefore we fail to reject the alternative hypothesis  
D. The test statistic fall within the rejection region therefore we reject the alternative hypothesis

18. An automotive manufacturer wants to know the proportion of new car buyers who prefer foreign cars over domestic. Suppose a random sample of 879 new car buyers is drawn. Of those sampled, 581 preferred domestic rather than foreign cars. Using the data, give the critical value of the 80% confidence interval for the population proportion of new car buyers who prefer foreign cars over domestic cars.

A. 1.645  
B. 0.84  
C. 1.28  
D. 1.96

19. A polling company would like to estimate the proportion of voters that will vote for the incumbent. How large a sample would be required in order to estimate the proportion of voters that will vote for the incumbent at the 90% confidence level with an error of at most 0.02? (Round your answer up to the next integer)

A. 423  
B. 1024  
C. 1692  
D. 256

20. A manufacturer of chocolate chips would like to know whether its bag filling machine works correctly at the 438 gram setting. Based on a random sample of 20 bags where the mean is 440 grams and the standard deviation is 11, a hypothesis test is performed to determine if there is sufficient evidence at the 0.05 level that the bags are underfilled. Was the test performed one-tailed or two-tailed?

A. One-tailed  
B. Two-tailed
Free Response: The Free Response questions will count 40% of your total grade. Read each question carefully. In order to receive full credit you must show legible and logical (relevant) justification which supports your final answer. You MUST show your work. Answers with no justification will receive no credit.

1. A research group for a diet company would like to estimate the average weight of women aged 40-55. A random sample of 15 women aged 40-55 is found to have an average weight of 136 lbs. with a standard deviation of 12 lbs. Assume weights of women aged 40-55 are normally distributed.

a. (4pts) What conditions are needed to calculate a 90% confidence interval to estimate the population mean weight of women aged 40-55 using the traditional methods? Are these conditions met and why?

1. Random Sample from Population – met because stated “random sample of 15 women”
2. Sampling Distribution of Sample Mean is Normally distributed – met because population is normally distributed “Assume weights of women aged 40-55 are normally distributed”

b. (5pts) What is a 90% confidence interval to estimate the population mean? Show your work. (Calculator calculations must include what was entered into the calculator)

\[ \bar{x} \pm t_{\alpha/2, n-1} \left( \frac{s}{\sqrt{n}} \right) \]

\[ 136 \pm (1.761) \left( \frac{12}{\sqrt{15}} \right) \]

\[ 136 \pm 5.453 \]

(130.546, 141.453)

1 pt for using t rather than z for critical value
1 pt for using correct degrees of freedom critical value (no credit for this point if using z)
1 pt for using \( \alpha/2 \) (0.05) for critical value
[For Example if 1.645 (-2), 1.96 (-3), 1.753 (-1), 1.345 or 2.145 (-1), 1.341 or 2.131 (-2)]
1 pt for using correct standard error
1 pt for using correct mean

Note if using calculator must indicate what was entered into calculator for any credit

c. (6pts) Interpret the interval you found in part b.

We are 90% confident that the interval 130.546 to 141.453 lbs. contains the population mean weight of women aged 40-55.

1 pt for saying confidence level (chance, likely, probability (0 pts))
1 pt for lower interval (follow work from b)
1 pt for higher interval (follow work from b)
1 pt for population mean
2 pts for context “weight of women aged 40-55” (1 pt for part of statement)
(-1 pt if sentence doesn’t make sense)
2. The Mars/M&M Corporation would like for there to be 20% yellow peanut M&M’s produced from their machine. A random sample of 3200 peanut M&M’s was collected from the production line. It was found that 18% of the sample were yellow. Use the steps below to determine if there is sufficient evidence that the proportion of all peanut M&M’s being produced that are yellow is different from 20% at the .05 significance level.

a. (4pts) State the null and alternative hypotheses.

\[ H_0: p = 0.20 \]
\[ H_A: p \neq 0.20 \]

NOTE: Student’s should not be punished for same mistake twice. However they should be consistent. For example if the student indicates a one sided test, rejection region and conclusions should also be one sided.

b. (4pts) What conditions must be met in order to perform the hypothesis test? Are these conditions met and why?

1. Random Sample from Population - stated in problem “random sample of 3200 peanut M&M’s”
2. \( np \geq 5 \) and \( n(1 - p) \geq 5 \)
   - \( 3200(0.20) = 640 \geq 5 \) and \( 3200(0.80) = 2560 \geq 5 \)

1 pt for each correct condition
1 pt for each correct reason condition is met
Any additional incorrect conditions subtract 1 for each (max of 2)

1 pt for not indicating with is null/alt
1 pt for p (rather than xbar or mu or p-hat)
1 pt for correct signs (equal, not equal)
1 pt for correct value (0.20)

c. (2pts) Which is the appropriate test? (Select one)
   - i. One Sample Hypothesis Test for mean
   - ii. One Sample Hypothesis Test for proportion **(Correct)**
   - iii. One Sample Hypothesis Test for variance

d. (4pts) Calculate the test statistic for your hypothesis test?

\[ z = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} = \frac{0.18 - 0.20}{\sqrt{\frac{(0.20)(0.80)}{3200}}} = -2.83 \]

2 pts for correct numerator
- (1 pt for “incorrect sign” reversing numerator)
2 pts for correct denominator
(if done by calculator if -2.83 is given assume numerator and denominator are correct)

2 pts for correct values
2 pts drawing picture

Rejection Region: \( z < -1.96 \) or \( z > 1.96 \)
f. (6pts) Based on your answers above what are your conclusions regarding your hypothesis test. **Why? Be sure to word your conclusion in terms of this particular question (i.e., about M&M’s).**

At the 5% significance level, my test statistics (z = -2.83) falls in my rejection region therefore I will reject my null hypothesis. There is sufficient evidence to suggest that the population proportion of all peanut M&M’s produced that are yellow is different from 20%.

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1 pt for rejecting null hypothesis
1 pt for indicating WHY rejecting null hypothesis
1 pts for indicating about POPULATION parameter (rather than sample or no indication at all)
1 pt for indicating proportion
1 pt for indicating correct context of population (all yellow M&M’s produced)
1 pt for indicating different from 20%