Multiple Choice: (Questions 1 - 16) 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 wildlife study is designed to find the mean weight of salmon caught by an Alaskan fishing company. A preliminary study of a random sample of 50 salmon showed a sample standard deviation of 2.15 pounds. How large a sample should be taken to be 95% confident that the sample mean is within 0.2 pound of the true mean weight?
   
   A) At least 22  
   B) At least 30  
   C) At least 313  
   D) At least 444

2. A new kind of typhoid shot is being developed by a medical research team. The old typhoid shot was known to protect the population for a mean time of 36 months, with a standard deviation of 3 months. To test the time variability of the new shot, a random sample of 23 people were given the new shot. Regular blood tests showed that the sample standard deviation of protection times was 1.9 months. The conditions for performing a hypothesis test were checked and verified. What is the test statistic in order to test the claim that the new typhoid shot has a smaller variance of protection times than the original?

   A) $\chi^2 = 36.32$  
   B) $\chi^2 = 54.85$  
   C) $\chi^2 = 34.74$  
   D) $\chi^2 = 8.82$

3. The manufacturer of a dietary shake claims their shakes will help people lose weight. The company obtains a random sample of 300 adults over the age of 25 who take the shake once a day as a replacement of one meal. The participants mean weight loss after 4 weeks was found to be 0.76 pound with standard deviation weight loss of 3.4 pounds. If you wanted to determine if there was sufficient evidence that the dietary shake performs as the company claims, which of the following are the appropriate hypotheses for this test?

   A) $H_0: \mu = 0.76 \quad H_A: \mu < 0.76$  
   B) $H_0: \mu = 0.76 \quad H_A: \mu > 0$  
   C) $H_0: \mu = 0 \quad H_A: \mu < 0$  
   D) $H_0: \mu = 0.76 \quad H_A: \mu > 0.76$
4. A random sample of 20 adult coyotes in a region of northern Minnesota showed the average age to be 2.05 years, with a sample standard deviation of 0.82 years. However, it is thought that the overall population mean age of coyotes is 1.75. You would like to test if the sample data indicate that coyotes in this region of northern Minnesota tend to live longer than the average of 1.75 years. The conditions for performing a hypothesis test were checked and verified. **What is the appropriate rejection region for this hypothesis test at the 0.05 significance level?**

A) \( t > 1.73 \)  
B) \( t > 1.96 \)  
C) \( z > 1.96 \)  
D) \( t > 2.09 \)

5. Some boxes of a certain brand of cereal include a voucher for a free Redbox video rental inside the box. The company that makes the cereal claims that a voucher can be found in 20 percent of the boxes. However, based on their experiences eating this cereal at home, a group of students believes that the proportion of boxes with vouchers is less than 0.2. This group of students purchased 65 boxes of cereal to investigate the company’s claim. Below is the Minitab output of the appropriate hypothesis test.

![Minitab Output](image)

**Which of the following is the correct interpretation of the p-value of this test?**

A) The sample proportion differs from the population proportion by 0.268.  
B) The sample proportion is 0.268 standard deviations above the mean.  
C) If the population proportion is 0.2, the probability of obtaining a test statistic of -0.62 or less is 0.268.  
D) The probability that the population proportion is 0.02 is 0.268.

6. The mayor of a town believes that 54% of the residents favor annexation of an adjoining community. A random sample of 1000 voters from the town 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. 510 residents that favored annexation  
C. All voters in this town  
D. All voters in the town that favor annexation
7. Each individual in a random sample of 60 college students was asked how much money he or she spent on food in a typical month. The data was then used to construct a 99% confidence interval for the actual mean amount spent on food for all students at the college in a typical month. The confidence interval was ($240, $380). **Which of the following is true about this 99% confidence interval for a population mean?**

A) The population mean falls exactly in the middle of the interval  
B) There is a 1% probability that the interval $240 to $380 will not capture the population mean  
C) The sample mean falls exactly in the middle of the interval  
D) All of the individuals sampled spent between $240 and $380 in a typical month.

8. A pharmaceutical company has developed a new drug to reduce cholesterol. The company collected data by giving the new drug to a random sample of 50 people from the population of people with high cholesterol. The reduction in cholesterol level after one month of use was recorded for each individual in the sample, resulting in a sample mean reduction and standard deviation of 24 mg/dl and 15 mg/dl respectively. A 99% confidence interval for the population mean reduction in cholesterol level for the new drug is found to be (19.737, 28.263). **Interpret what it means to be “99% confident” in this interval.**

A) There is a 99% probability that the population mean reduction in cholesterol level for the new drug is contained in the interval 19.737 to 28.263.  
B) In repeated sampling, using the same method used to create the interval 19.737 to 28.263, 99% of the intervals created will capture the population mean reduction in cholesterol level for the new drug.  
C) In repeated sampling, 99% of the sample means calculated will fall in the interval 19.737 to 28.263.  
D) There is a 99% chance that the interval 19.737 to 28.263 will capture the mean reduction in cholesterol level for the new drug of the 50 people sampled.

9. Which of the following are the conditions for inference for a chi-square test for standard deviation?

I. Random Sample from the population  
II. $\chi^2$ is normally distributed  
III. Population random variable is normally distributed  
IV. Sample size is larger than 30

A) I and II  
B) I and III  
C) I and IV  
D) I and III or IV
10. In a marketing survey, a random sample of 1001 supermarket shoppers revealed that 273 always stock up on an item when they find that item at a real bargain price. **What is the critical value for a 97% confidence interval for the proportion of all supermarket shoppers who always stock up on an item when they find a real bargain?**

   A) 1.88  
   B) 2.17  
   C) 0.52  
   D) 1.96

11. The manufacturer of processed deli meats reports that the standard deviation of the number of carbohydrates in its smoke turkey breast is 0.5 gram per 2 ounce serving. A dietician does not believe the manufacturer and random selects eighteen 2 ounce servings of the smoked turkey breast and determines the number of carbohydrates per serving. The standard deviation of the number of carbs is computed to be 0.62 gram per serving. The conditions for performing a hypothesis test were checked and verified. **If you are performing a hypothesis test to determine if there is sufficient evidence to indicate that the standard deviation is not 0.5 gram per serving at the 0.05 level of significance what is the appropriate rejection region?**

   A) $\chi^2 < 8.672 \text{ or } \chi^2 > 27.587$  
   B) $\chi^2 < 7.564 \text{ or } \chi^2 > 30.191$  
   C) $\chi^2 > 27.587$  
   D) $\chi^2 < 8.231 \text{ or } \chi^2 > 31.526$

12. A Harris Interactive poll conducted during January 2008 found that 944 of 1748 randomly selected adult Americans 18 years or older who do not have a tattoo believe that individuals with tattoos are more rebellious. **Obtain a point estimate for the proportion of Americans without tattoos who believe individuals with tattoos are more rebellious**

   A) 944  
   B) 0.54  
   C) 0.012  
   D) 0.47

13. What is the relationship between $\alpha$ (probability of Type 1 error) and $\beta$ (probability of type 2 error)?

   A) As $\alpha$ increases, $\beta$ increases  
   B) As $\alpha$ increases, $\beta$ decreases  
   C) The relationship depends on the context of the hypothesis test  
   D) Both $\alpha$ and $\beta$ are independent of one another
14. Which of the following is certain to reduce the width of a confidence level?

   A) Larger sample size and higher confidence level
   B) Larger sample size and lower confidence level
   C) Smaller sample size and higher confidence level
   D) Smaller sample size and lower confidence level

15. 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.

16. A humane society wanted to estimate with 95 percent confidence the proportion of households in its county that own at least one dog. The humane society selected a random sample of households in its county and used the sample to estimate the proportion of all households that own at least one dog. The conditions for calculating a 95 percent confidence interval for the proportion of households in this county that own at least one dog were checked and verified, and the resulting confidence interval is in the Minitab output below. What is the margin of error for the interval calculated?

   ![Test and CI for One Proportion](image)

   A) 0.4154
   B) 0.0073
   C) 0.1198
   D) 0.1859
Free Response: The Free Response questions will count 52% 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. (4 pts) A magazine company is planning to survey customers to determine the proportion who will renew their subscription for the coming year. The magazine wants to estimate the population proportion with 95% confidence and a margin of error equal to 0.03. What is the minimum sample size required? Show work by filling in values to the appropriate formula and give units.

\[
n = \frac{(1.96)^2(0.5)^2}{0.03^2} = 1067.111
\]

\[
n = 1068 \text{ customers}
\]

- 1 points correct z-value
- 1 point for following formula
- 1 point for rounding up
- 1 point units
- -0.5 for minor arithmetic errors
2. Allante Pizza delivers pizzas throughout its local market area at no charge to the customer. However, customers often tip the driver. The owner is interested in estimating the mean tip income per delivery. To do this, she has selected a simple random sample of 12 deliveries and has recorded the tips that were received by the drivers. Assume tip income is normally distributed. The data are given in the table below:

<table>
<thead>
<tr>
<th>$2.25</th>
<th>$2.50</th>
<th>$2.25</th>
<th>$2.00</th>
<th>$2.00</th>
<th>$1.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.25</td>
<td>$2.00</td>
<td>$1.50</td>
<td>$2.00</td>
<td>$3.00</td>
<td>$1.50</td>
</tr>
</tbody>
</table>

The sample standard deviation of the data above is 0.494.

Suppose the owner is interested in developing a 90% confidence interval for the population mean tip income per delivery.

A) (4pts) List and verify the conditions required to calculate the appropriate confidence interval.

1. Randomly sample from population – stated in problem
2. \( \bar{X} \) normally distributed – population normally distributed is stated in the problem therefore \( \bar{X} \) is normally distributed

\( \square \) 1 point for each condition, 1 point for each justification

Grading Notes:
- It is ok if student states “random sample” as condition, however just “random” is not ok
- Must indicate that random sample is stated in the problem either by stating or underlying “random” in problem – some indication that this condition was checked correctly (not just a check mark)

B) (5 pts) Calculate the appropriate 90% confidence interval. Show work by filling in values to the appropriate formula and giving calculations to 3 decimal places.

\[
\bar{X} \pm t_{a/2} \frac{s}{\sqrt{n}}
\]

\[
1.979 \pm (1.796) \frac{0.494}{\sqrt{12}}
\]

\[
(1.723, 2.235)
\]

\( \square \) 1 point for correct point estimate (1.979) (notation “\( \bar{X} \)” and value)
\( \square \) 2 points for correct critical value (notation “\( t \)” and value)
\( \square \) 2 points for correct standard error notation and value

Grading Notes:
- Must show formula and values plugged into formula
- Subtract 1 for minor calculation errors
- Intervals with no formula (or only computer syntax) will receive NO credit
C) (6 pts) Interpret the interval you found in part b.

We are 90% confident that the interval 1.723 to 2.235 captures the population mean tip income per delivery.

- If clearly stating interpretation about sample proportion mark entire part as incorrect.
- Otherwise
  - 2 points for using the word confidence (not probability, likely, chance, etc.) “sure” is ok
  - 2 points for the correct context of the problem
  - 2 points for clearly stating population mean (“population”, “all”, “true” etc.)
3. A report summarized a survey of 304 randomly selected US businesses. Of these companies, 238 indicated that they monitor employees’ web site visits. Is there sufficient evidence to suggest that more than 75% of US businesses monitor employees’ web site visits? Test the appropriate hypotheses using a significance level of 0.01 and the step below.

a. (4 pts) Give the appropriate hypotheses for this test.

\[ H_0: p = 0.75 \]
\[ H_A: p > 0.75 \]

Where \( p \) is the population proportion of companies that monitor employees’ web site visits. (not necessary to receive full credit)
[1 point for population symbol, 1 point for proportion, 1 point for signs, 1 point for value]
(if used x-bar minus 2)

b. (4 pts) List and Verify conditions for the appropriate hypothesis test

1. Randomly sample from population – stated in problem
2. P-hat normally distributed – \( np = 304(0.75) = 228 \geq 5; n(1 - p) = 304(0.25) = 76 \geq 5 \)

\( \square \) 1 point for each condition, 1 point for each justification

Grading Notes:

- It is ok if student states “random sample” as condition, however just “random” is not ok
- Must indicate that random sample is stated in the problem either by stating or underlying “random” in problem – some indication that this condition was checked correctly (not just a check mark)
- It is ok if student states \( np \geq 5; n(1 - p) \geq 5 \) as the condition rather than p-hat normally distributed. In other words the statement \( np = 304(0.75) = 228 \geq 5; n(1 - p) = 304(0.25) = 76 \geq 5 \) will receive credit for condition and justification
- Must indicate some comparison to 5 (cannot just calculate 228 and 76 without indicating comparing them to 5)
- If the student uses hats when stating the condition they lose the point for the condition but may get credit for checking condition.
- If an extra condition is stated and checked (such as population normally distributed) subtract 1 point

b. (3 pts) Give the appropriate test statistic. Show formula, work, and value.

\[ z = \frac{\hat{p} - p}{\sqrt{\frac{p(1 - p)}{n}}} = \frac{0.78 - 0.75}{\sqrt{\frac{(0.75)(0.25)}{304}}} = 1.21 \]

[-1 for minor arithmetic errors, -3 for reversing p-hat and p, -1 for formula without values plugged in]
d. (5 pts) Find the appropriate p-value. Draw an appropriate picture, show work, and give the value to 4 decimal places.

\[ P(Z > 1.21) = 0.1131 \]

1 pt for work (picture or formula or probability statement), 2pts for p-value, 2 pts for picture
- find rejection region -3 for p-value and work)
- incorrect rejection region -4

e. (5 pts) What is your decision regarding the null hypothesis? Explain.

At the 1% significance level, my p-value (0.1131) is greater than alpha (0.01) therefore I do not reject the null hypothesis.
- Correct decision with no reason why -3
- Correct decision with Wrong or invalid comparison -3
- Incorrect decision with valid comparison -3

f. (5 pts) What are your conclusions about this particular test?

There is insufficient evidence to suggest the population proportion of US businesses that monitor employee’s webs site visits is greater than 75%.
- Conclusion correct decision but NOT about alternative hypothesis -2
- no indication of population parameter (US, population, etc.) -1
- with correct conclusion but not in context -1
- with correct conclusion but not about proportion/percentage -1
- If conclusion is clearly about sample proportion -5
- If conclusion is not consistent with decision from part e (indicating wrong conclusion) -5
4. (6 pts) When a law firm represents a group of people in a class action lawsuit and wins that lawsuit, the firm receives a percentage of the group’s monetary settlement. That settlement amount is based on the total number of people in the group – the larger the group and the larger the settlement, the more money the firm will receive.

A law firm is trying to decide whether to represent car owners in a class action lawsuit against the manufacturer of a certain make and model for a particular defect. If 5 percent or less of the cars of this make and model have the defect, the firm will not recover its expenses. Therefore, the firm will handle the lawsuit only if it is convinced that more than 5 percent of cars of this make and model have the defect. The firm plans to take a random sample of 1,000 people who bought this car and ask them if they experienced this defect in their cars.

The lawyers are testing the following hypothesis:

\[ H_0: p = 0.05 \]
\[ H_A: p > 0.05 \]

a. In the context of this situation, describe a Type II error.

Type II error would be finding that the proportion of cars of this make and model have the defect when is not greater than 0.05 when in fact it is greater than 5%.

3 pts – Either right or wrong

b. Describe a consequence of that error for the law firm.

The law firm will not pursue lawsuit when it would potentially be profitable for them.

3 pts – A logical consequence based on their answer in part a.

5. (1 pt) If your scantron is correctly bubbled with a #2 pencil, with your correct XID (with the “C” bubbled in as a “0”), your correct test version, AND the front of your test is completed with your signature on the academic integrity statement, you earn 1 point.

END OF TEST