1. **Don’t even open this until you are told to do so.**

2. All graphs are on the last page which you may remove.

3. There are 20 multiple-choice questions on this exam, each worth 5 points. There is partial credit. Please mark your answers **clearly**. Multiple marks will be counted wrong.

4. You will have 60 minutes to finish this exam.

5. If you have questions, please write out what you are thinking on the back of the page so that we can discuss it after I return it to you.

6. If you are caught cheating or helping someone to cheat on this exam, you both will receive a grade of **zero** on the exam. You must work alone.

7. This exam is worth the 15% of your course grade.

8. When you are finished please make sure you have marked your CORRECT section (Tuesday 12:45 is 508, 2:20 is 509, and 3:55 is 510) and FORM and 20 answers, then turn in JUST your scantron to the correct pile for your section.

9. Good luck!
1. What are the $z$ critical values, the $z_{\alpha/2}$, for a 58% confidence interval?
   A. $\pm 0.719$
   B. $\pm 0.58$
   C. $\pm 0.20$
   D. $\pm 0.61$
   E. $\pm 0.81$

2. Which statement agrees with $P(p_{40} \geq 0.30)$ for $p_{40} \sim N(0.25, 0.068^2)$? $n = 40$
   A. What sample proportion is the upper 30% of this population with mean 0.25 and standard deviation 0.068?
   B. How likely are you to get 30% or more if you sample a population of 40?
   C. How likely are you to get a probability of 0.30 if you sample a population with mean 0.25 and standard deviation 0.068?
   D. How likely are you to get a sample proportion of 30% or more if you take a sample of 40 from a population with mean 25% and standard deviation 6.8%?
   E. Math doesn’t equate to words.

3. A certain population follows a normal distribution with mean $\mu$ and standard deviation $\sigma = 2.5$. You collect data and test the hypotheses:
   
   $H_0 : \mu = 1$
   $H_A : \mu \neq 1$
   
   You obtain a $p$-value of 0.022. Which of the following is true??
   A. A 95% CI for $\mu$ will include the value 1.
   B. A 95% CI for $\mu$ will include the value 0.
   C. A 99% CI for $\mu$ will include the value 1.
   D. A 99% CI for $\mu$ will include the value 0.
   E. We can’t determine since we can’t relate confidence intervals to tests of hypotheses.

4. Let $X \sim N(1, 2^2)$. If the probability of getting one $X$ at least 2 units (not standard deviations) from its mean (greater than 2 units above or below its mean) is 0.3174, the probability of getting a sample mean of 4, $\bar{X}$, at least this far from its mean will be
   A. more, 0.9544.
   B. less, 0.0228.
   C. less, 0.0456.
   D. more, 0.6826.
   E. the same, 0.3174.

5. Using the information above, what is the correct range of the $p$-value if I wanted to test $H_0 : \mu = 0$ vs. $H_A : \mu \neq 0$?
   A. $p$-value > 0.10
   B. 0.10 > $p$-value > 0.05
   C. 0.05 > $p$-value > 0.01
   D. $p$-value < 0.01
   E. You need a test statistic value to determine the $p$-value

6. What would be the range of the $p$-value if we were testing $H_0 : \mu = 17$ vs. $H_A : \mu \neq 17$ instead, but still used the 3 confidence intervals above?
   A. $p$-value > 0.10
   B. 0.10 > $p$-value > 0.05
   C. 0.05 > $p$-value > 0.01
   D. $p$-value < 0.01
   E. You need a test statistic value to determine the $p$-value

7. Let $X \sim N(7.2, 1.4^2)$. If we take a random sample of size 49 from this population, what is the distribution of the sample mean, $\bar{X}_{49}$?
   A. Since the sample size is large, $> 30$, we can say the distribution will be approximately normal with the same mean and standard deviation.
   B. Since the original data is normal, we can say the distribution will be exactly normal with the same mean and standard deviation.
   C. Since the sample size is large, $> 30$, we can say the distribution will be approximately normal with the mean, $\mu_{\bar{X}} = 7.2$ and standard deviation, $\sigma_{\bar{X}} = \frac{1.4}{\sqrt{49}}$.
   D. Since the original data is normal, we can say the distribution will be exactly normal with the mean, $\mu_{\bar{X}} = 7.2$ and standard deviation, $\sigma_{\bar{X}} = \frac{1.4}{\sqrt{49}}$.
   E. $\bar{X} \sim N(7.2, 0.029^2)$.

8. What can we do to reduce the length of a 95% confidence interval for $\mu$ but leave the confidence level at 95%?
   A. reduce the sample mean, $\bar{x}$
   B. reduce the sample size, $n$
   C. reduce the population standard deviation, $\sigma$
   D. reduce the $z$ critical value, $z_{\alpha/2}$
   E. Two of the above will reduce the length.
9. If we each generated 200 random samples from a population of \( N(4, 10^2) \). From these samples, we created 200 95% confidence intervals. Which of the following is/are true?

A. It is plausible that 14 of them didn’t contain 4.
B. It is possible that all of them actually contained 4.
C. We would mostly likely have 10 intervals that didn’t contain 4.
D. All of the above are true.
E. Exactly two of the statements above are true.

10. Which of the following statements is correct?

A. An extremely small \( p \)-value indicates that the actual data differs markedly from that expected if the null hypothesis were true.
B. The \( p \)-value measures the probability that the null hypothesis is true.
C. The \( p \)-value measures the probability of making a Type II error.
D. The larger the \( p \)-value, the stronger the evidence against the null hypothesis.
E. None of the above statements are true.

11. It’s almost Halloween and pirates abound. The following table gives the type, value and probability (based on the count) of a particular treasure chest. What are the mean and median value of the jewels?

<table>
<thead>
<tr>
<th>type</th>
<th>Emerald</th>
<th>Ruby</th>
<th>Diamond</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>$450</td>
<td>$500</td>
<td>$1000</td>
<td>$300</td>
</tr>
<tr>
<td>prob</td>
<td>0.4</td>
<td>0.2</td>
<td>0.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>

A. \( \mu = $1237.50 \) and \( \bar{X} = $500 \)
B. \( \mu = $6100 \) and \( \bar{X} = $500 \)
C. The probability measures the probability of making a Type II error.
D. The larger the \( p \)-value, the stronger the evidence against the null hypothesis.
E. None of the above statements are true.

12. Assuming each grab is independent, how likely is a pirate to reach in a get exactly one emerald, one ruby and one diamond? It doesn’t matter if he reaches in 3 times for one stone each or gets 3 stone with one grab.

A. 0.9
B. $1950
C. 0.024
D. 0.24
E. 0.25

13. Which of the following best describes the relationship between a \( (1 - \alpha)100\% \) confidence interval for \( \mu \) and a 2-sided test of hypotheses for \( \mu = \) some value, \( \mu_0 \)?

A. There is no relationship between confidence intervals and hypothesis tests.
B. If the hypothesized value, \( \mu_0 \), falls within the confidence interval, we would reject the null.
C. If the hypothesized value, \( \mu_0 \), falls within the confidence interval, we would fail to reject the null.
D. If the confidence interval contains 0, we would reject the null.
E. If the confidence interval contains 0, we would fail to reject the null.

14. Let \( X \) be the distribution of test scores, \( X \sim N(75, 8^2) \). What is the probability that a student makes a B, \( P(80 < X \leq 89) \)?

A. 0.2242
B. 0.6956
C. 0.4360
D. 0.2596
E. We can’t do probabilities with \( \leq \)’s only <.

15. The level of nitrogen oxides (NOX) in the exhaust of a particular car model varies. A company has 200 cars of this model in its fleet. We’re interested in obtaining a confidence interval for the mean NOX emission level. The data doesn’t appear to come from a normal distribution but it’s not too far from normality and no outliers are present. Assuming a sample size of 200 is large enough, why can we use the confidence interval ordinarily reserved for normal data?

A. Statistics is a fairly flexible science. You can get away with a lot more than you think.
B. The Central Limit Theorem says it’s justified.
C. It’s justified since we’re using a typical level of confidence, 95%.
D. The confidence interval for the normal distribution is used when the data is numerical, especially when the variable is continuous such as measuring the diameter of a piston.
E. We can’t use the normal confidence interval here.

16. What is the 25th percentile of \( X \sim N(35, 6^2) \)?

A. 0.25
B. $-0.675
C. 36.5
D. 33.5
E. 30.95
17. Suppose a sample proportion based on samples of size 50, \( p_{50} \sim N(0.75, 0.0612^2) \). What is the smallest proportion in the TOP 5%?

A. 0.753  
B. 0.649  
C. 0.872  
D. 0.870  
E. 0.851

18. Which of the following theorems and/or rules is NOT stated correctly?

A. If the population distribution is normal then the distribution of the sample mean is approximately normal.  
B. \( \sigma_{X-Y} = \sigma_X^2 - \sigma_Y^2 \) if \( X \) and \( Y \) are independent.  
C. \( \mu_{X-Y} = \mu_X - \mu_Y \)  
D. All of the above are not stately correctly.  
E. Only two of the above are not stately correctly.

19. We test the null hypothesis \( H_0: \mu = 10 \) and the alternative \( H_A: \mu < 10 \), for a normal population with \( \sigma = 4 \). A random sample of 16 observations is drawn from the population, and we find the sample mean of these observations is \( \bar{x} = 12 \). The \( p \)-value is closest to

A. 0.0228  
B. 0.0456  
C. 0.10  
D. 0.9772  
E. 0.6915

20. Suppose that machine 1 is denoted by the r.v. \( X_{81} \) and machine 2 by \( W_{64} \). What is the standard deviation of \( X_{81} - 2W_{64} \)?

A. 8  
B. 32  
C. 64  
D. \( \sqrt{40} \)  
E. \( \sqrt{832} \)

21. Suppose that we want to test the hypothesis \( H_0: \mu_X = \mu_W \) vs. \( H_A: \mu_X \geq \mu_W \) with an \( \alpha = 0.05 \). We found that the \( p \)-value = 0.003. Which of the following statements is TRUE?

A. Machine 1 has a mean significantly larger than machine 2.  
B. There is not enough evidence to reject the hypothesis that machine 1 has a larger mean than machine 2.  
C. We fail to reject the hypothesis that machine 1 has smaller mean than machine 2.  
D. None of the above is TRUE.  
E. Two of the above are TRUE.