1. Each figure below displays the sampling distribution of a statistic used to estimate a parameter. The true value of the population parameter is marked on each sampling distribution. Which is the sampling distribution of a statistic that is an unbiased estimator of the parameter of interest?

A. Statistic I only
B. Statistic II only
C. Statistic III only
D. Both Statistic I and Statistic II are unbiased
E. None of the three statistics are unbiased.
2. Four different statistics are being considered for estimating a population characteristic. The sampling distributions of the four statistics are shown here. Which statistic is most likely to result in an estimate that is close to the true value of the population characteristic?

![Sampling distributions of statistics](image)

A. Statistic I  
B. Statistic II  
C. Statistic III  
D. Statistic IV  
E. Statistics III and IV are equally likely to result in an estimate that is close to the true value.

3. Given a choice of unbiased statistics, the best statistic would be the one with a sampling distribution that

A. is most closely approximated by a normal curve.  
B. has the smallest variance.  
C. has the largest standard error.  
D. is most nearly symmetric.  
E. is most closely approximated by a $t$ distribution.

4. To estimate the proportion of faculty at a state university who own a home, a random sample of faculty is selected. For which of the following combinations of $n$ and $\hat{p}$ would it be appropriate to use the confidence interval $\hat{p} \pm (z \text{ critical value}) \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$?

A. $n = 20$ and $\hat{p} = 0.40$  
B. $n = 40$ and $\hat{p} = 0.20$  
C. $n = 100$ and $\hat{p} = 0.05$  
D. $n = 150$ and $\hat{p} = 0.45$  
E. $n = 200$ and $\hat{p} = 0.02$
5. Suppose that a random sample of 100 high school classrooms in the state of California is selected and a 95% confidence interval for the proportion that has internet access is (0.62, 0.78). Which of the following is a correct interpretation of the 95% confidence level?

A. The method used to construct the interval will produce an interval that includes the value of the population proportion about 95% of the time in repeated sampling.
B. We are 95% confident that the sample proportion is between 0.62 and 0.78.
C. There is a 95% chance that the true proportion of high school classrooms in California that have internet access is between 0.62 and 0.78.
D. We are 95% confident that the true proportion of high school classrooms in California that have internet access is between 0.62 and 0.78.
E. None of the above is a correct interpretation of the confidence level.

6. Which of the following must be true of a sample in order for it to be appropriate to use a z confidence interval to estimate the population proportion?

A. The sample is a random sample from the population of interest.
B. $n\hat{p} \geq 10$ and $n(1 - \hat{p}) \geq 10$
C. The population distribution is normal.
D. All of the above are required assumptions to use the z confidence interval to estimate the population proportion.
E. Only (a) and (b) are required assumptions to use the z confidence interval to estimate the population proportion.

7. Which of the following would tend to decrease the width of a confidence interval?

I. Increasing the sample size
II. Using a higher confidence level
III. Using a lower confidence level

A. I only
B. II only
C. III only
D. I and II only
E. I and III only
8. Each individual in a random sample of 60 college students was asked how much money he/she spent on food in a typical month. The data was then used to construct a 99% confidence interval for the true 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 closest to the 95% confidence interval constructed using the same sample data?

A. (240, 380)
B. (250, 370)
C. (260, 360)
D. (270, 350)
E. (280, 340)

9. Each individual in a random sample of 50 internet users was asked how many minutes he/she spends online in a typical day. The data was then used to construct a 99% confidence interval for the mean number of minutes spent online in a typical day for all internet users. The confidence interval was (80, 200) minutes per day. Which of the following is a correct interpretation of the confidence interval?

A. There is a 99% chance that the mean number of minutes spent online in a typical day of all internet users is between 80 and 200.
B. We are 99% confident that the sample mean is between 80 and 200 minutes.
C. We are 99% confident that for all internet users the mean number of minutes spent online in a typical day is between 80 and 200.
D. 99% of all internet users will spend between 80 and 200 minutes online in a typical day.
E. 99% of the people in the sample spent between 80 and 200 minutes online in a typical day.

10. Two-hundred visitors to a national park were selected at random and each was asked whether they intended to stay more than 2 nights in the park on that visit. Assuming that the sample size is large enough, which of the following confidence intervals should be used to estimate the proportion of all visitors to this national park who will stay more than 2 nights on their visit?

A. $\bar{x} \pm (t \text{ critical value}) \frac{s}{\sqrt{n}}$
B. $\hat{p} \pm (t \text{ critical value}) \frac{s}{\sqrt{n}}$
C. $\hat{p} \pm (z \text{ critical value}) \frac{s}{\sqrt{n}}$
D. $\bar{x} \pm (z \text{ critical value}) \frac{\sigma}{\sqrt{n}}$
E. $\hat{p} \pm (z \text{ critical value}) \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$
11. Two-hundred visitors to a national park were selected at random and each was asked how far they had traveled to get to the park on that visit. Which of the following confidence intervals should be used to estimate the mean number of miles traveled by all visitors to the park?

A. \( \bar{x} \pm (t \text{ critical value}) \frac{s}{\sqrt{n}} \)

B. \( \mu \pm (t \text{ critical value}) \frac{s}{\sqrt{n}} \)

C. \( \mu \pm (z \text{ critical value}) \frac{\sigma}{\sqrt{n}} \)

D. \( \bar{x} \pm (z \text{ critical value}) \frac{\sigma}{\sqrt{n}} \)

E. \( \hat{p} \pm (z \text{ critical value}) \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \)

12. Suppose you take a simple random sample from a population known to be normally distributed, but the value of \( \sigma \) is unknown. Your sample size is \( n = 10 \). Which formula below should be used to find the 90% confidence interval for the mean?

A. \( \bar{x} \pm 1.645 \frac{s}{\sqrt{10}} \)

B. \( \bar{x} \pm 1.645 \frac{\sigma}{\sqrt{10}} \)

C. \( \bar{x} \pm 1.833 \frac{s}{\sqrt{10}} \)

D. \( \bar{x} \pm 1.812 \frac{\sigma}{\sqrt{10}} \)

E. \( \bar{x} \pm 1.833 \frac{\sigma}{\sqrt{10}} \)
13. A large sample \((n = 250)\) was used to compute \(\bar{x} \pm \frac{s}{\sqrt{n}}\). This interval is equivalent to a

A. 50% confidence interval.
B. 68% confidence interval.
C. 84% confidence interval.
D. 90% confidence interval.
E. 95% confidence interval.

14. Which of the following is certain to reduce the width of a confidence interval?

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
E. None of the above.

15. The critical value for a 99% confidence interval for \(p =\)

A. 2.33  B. 2.58  C. 2.97  D. 3.09  E. 3.29

16. What is the difference between a t-interval and z-interval?

A. z-intervals are used if you know the population’s standard deviation and t-intervals are used when you do not know the population’s standard deviation.
B. t-intervals are used if you know the population’s standard deviation and z-intervals are used when you do not know the population’s standard deviation.
C. t-intervals are used when the sample size is much larger than in z-intervals
D. z-intervals are used when the data are not normally distributed
E. t-intervals use the sample size where z-intervals use \(n-1\) degrees of freedom

17. Assuming that the data came from a random sample, what other conditions must be met in order to perform a z-interval on a single proportion?

A. The sample size is greater than 30 or the data are roughly normal.
B. The population of interest is greater than the sample size.
C. The population is greater than 10 times the sample size.
D. The probability of success times sample size is greater than 10 as well as the probability of failure times the sample size is greater than 10.
E. Both C and D must be true for a proportion interval to be constructed.
18. A researcher wants to find a reasonable interval of the mean time it takes to complete an order over the phone at a call center for a large retail company. He has selected a sample of 18 calls and recorded the time to completion on the phone to be 4.27 minutes with a standard deviation of 0.78 minutes. What is the appropriate interval if he wants to use a 98% confidence level?

A. 4.27 ± 2.326 \( \frac{0.78}{\sqrt{18}} \)

B. 4.27 ± 2.054 \( \frac{0.78}{\sqrt{17}} \)

C. 4.27 ± 2.552 \( \frac{0.78}{\sqrt{18}} \)

D. 4.27 ± 2.567 \( \frac{0.78}{\sqrt{18}} \)

E. 4.27 ± 2.567 \( \frac{0.78}{\sqrt{17}} \)

19. What size would a sample need to be in order for it to be within 3 percentage points on a 95% confidence interval when the proportion of successes is 36%?

A. 984  
B. 983  
C. 256  
D. 255  
E. 250

20. Which of the following would not decrease the width of a confidence interval?

I. increasing the sample size  
II. increasing the standard deviation  
III. decreasing the confidence interval  

A. I only  
B. II only  
C. III only  
D. I and II  
E. II and III

21. In a study with a new antibiotic for children, a random sample of 64 showed that 52 of the children had positive results within 12 hours. Find a 95% confidence interval for the proportion of children who will experience positive results within 12 hours on this antibiotic.

A. 0.8125 ± 0.096  
B. 0.8125 ± 0.080  
C. 0.8125 ± 0.071  
D. 0.8254 ± 0.079  
E. 0.8253 ± 0.094

22. The average number of minor medical needs at any Army hospital in Iraq over a 49-day period was found to be 11.2 with a standard deviation of 3.6 per day. With what degree of confidence can we say that the minor medical needs at the Army hospital per day is between 10.3 and 12.1?

A. 80%  
B. 85%  
C. 90%  
D. 95%  
E. 98%
23. What assumptions are necessary for a 95% t-interval with a sample size of 9 to be valid?
   I. The sample was selected randomly from the population of interest.
   II. The population standard deviation is known
   III. The sample can be shown to be approximately normal with no skewness.

A. I only      B. III only      C. I and II only      D. I and III only      E. I, II and III

24. A 98% confidence interval for a population mean is found to be 127 ± 18. Which of the following
    is a correct interpretation of this level?

A. There is 98% probability that the true mean is contained in this interval.
B. There is 98% probability that the sample mean is contained in this interval.
C. There is 98% probability that another interval will give a true mean of 127.
D. If 100 samples of the same size are taken again, about 98 of them will contain the true mean value.
E. If 100 samples of the same size are taken again, about 98 of them will contain the true sample value.

25. When the sample size is increased what effect does this have on the size of the confidence interval?

A. It makes it wider. Depending on how much the sample is increased by, this will make the interval wider.
B. It will make the interval narrower. The larger the sample gets, the smaller the width of the interval.
C. It will have no effect on the width because this would only change based on the level of confidence.
D. It will double the width of the interval since you are now multiplying by an additional \( \sqrt{n} \) size.
E. It will cut the interval in half since you are now dividing by an additional \( \sqrt{n} \) size.

26. You have been asked to compute a 96% confidence interval for a population mean. If the population standard deviation is known to be 7 and the sample size is 40, what is the value of \( z^* \) that will be used to perform this calculation?

A. 2.125      B. 2.122      C. 1.960      D. 1.751      E. 2.054

27. A community wants to see if there is enough support to hold a town children’s festival. Forty-two percent of the 150 residents said they would participate in the event. What would be the approximate standard error for this sample proportion?

A. 0.03      B. 0.24      C. 0.02      D. 0.04      E. 0.002
28. A Fortune 500 company wants to design a study to estimate the proportion of employees who would prefer a pay increase to an increase in retirement benefits. The company statistician wants to generate a 95% confidence interval with a margin of error being 0.04 or smaller. What is the minimum sample size needed for this study?

A. 600 employees  
B. 601 employees  
C. 307 employees  
D. 156 employees  
E. 157 employees

29. A consumer group just published a study stating that 72% of Americans believe corporations are not concerned about public safety, with a 90% confidence level and a margin of error of 2%. What does this mean?

A. If the poll were conducted again, there is a 90% probability that Americans who believe corporations are not concerned about safety are within a margin of error of 2%.  
B. There is a 90% chance that the proportion of Americans who believe corporations aren’t concerned with public safety is between 70% and 74%.  
C. From 90% of all Americans, about 70% to 74% believe corporations are not concerned with public safety.  
D. They are 90% confident that the true percentage of Americans who believe corporations are not concerned with public safety is between 70% and 74%.  
E. Ninety out of 100 Americans who believe corporations are not concerned with public safety is 70% and 74% in repeated sampling.

Free Response
30. A large Midwestern forest planted by the CCC at the end of the depression is now too thick for safe tree growth and many sections are beginning to die. The state forestry commission has hired a lumber company to begin cutting down enough trees to allow the healthier trees to continue to grow. A sample of 204 trees found that 28% of the trees must be removed to allow further growth.

a. What conditions need to be checked in order to calculate a confidence interval?

b. If the forestry commission wants to estimate the proportion of the total forest population that will need to be removed, calculate a 95% confidence interval to predict the amount of cutting that will occur.

c. Interpret this interval and explain why this is reasonable.
31. An AP coordinator in an urban school district mandates that AP students take a practice exam, called a Mock Exam, in the spring to help identify student potential scores on the upcoming exam in May. A random sample of AP students’ Mock Exam was taken and the scores recorded. The results for 28 of the students were found to be:

<table>
<thead>
<tr>
<th>AP Mock Exam Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>58  76  74  80  88  74  65</td>
</tr>
<tr>
<td>97  66  95  77  63  83  73</td>
</tr>
<tr>
<td>64  71  60  68  70  63  71</td>
</tr>
<tr>
<td>57  75  74  52  71  81  82</td>
</tr>
</tbody>
</table>

a. Construct a 90% confidence interval for the mean score on the AP Mock Exams given in this district. Justify your answer.

b. Explain why the answer is reasonable

c. The district has found in previous years that their students tend to score a passing score on the national exam (that is 3-5) if the Mock scores are at least a 70. Can the AP coordinator feel confident in this year’s results? Explain how you arrived at this conclusion.

32. A humane society wanted to estimate with 95 percent confidence the proportion of households in its county that own at least one dog.

(a) Interpret the 95 confidence level in this context.

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 was 0.417 ± 0.119.

(b) A national pet products association claimed that 39 percent of all American households owned at least one dog. Does the humane society’s interval estimate provide evidence that the proportion of dog owners in its county is different from the claimed national proportion? Explain.

(c) How many households were selected in the humane society’s sample? Show how you obtained your answer.
Answer Key:

1. C
2. C
3. B
4. D
5. A
6. E
7. E
8. C
9. C
10. E
11. A
12. C
13. B
14. B
15. B
16. A
17. E
18. D
19. A
20. B
21. A
22. C
23. D
24. D
25. B
26. E
27. D
28. B
29. D

30. a. Since this is a proportions case, the following four conditions must be met to run this interval. We need to assume the sample came from a simple random sample of trees. 
   \[ 204(0.28) = 57.12 \geq 10, \text{ this is ok} \] and 
   \[ 204(0.72) = 146.88 \geq 10, \text{ this is ok} \] 
   \[ 10(204) = 2040, \text{ as long as the forest had more than 2040 trees, then you can proceed with a confidence interval.} \]

b. Based on a 95% confidence level, the proportion of trees from the forest needing to be removed would reasonably be within (0.218, 0.341)

c. I am 95% confident that the true proportion of trees needing to be removed from the forest is between 21.8% and 34.1%. I am confident in this because the method used will capture the true proportion of trees needing to be removed 95 out of 100 times in repeated sampling.

31. a. Since this is means data and we do not know the populations standard deviation, a t-interval needs to be used. The justification is found in checking the conditions needed for a t-interval. The problem stated it was a random sample so we will assume this is sufficient. Since the sample size is slightly under 30, we will still check for the data being roughly normal. Either a boxplot or normal probability plot would suffice. In both cases there is no reason to doubt the sample data are roughly normally distributed so we can proceed to the calculations. 
   The interval would be (69, 76)

b. This is a reasonable solution because the method used for generating a t-interval will capture the true test average 90 out of 100 times in repeated sampling.

c. Since the interval is from 69 to 76, I am 90% confident that is the true mean AP Mock score is contained in this interval. Further, since the district is looking for students to score 70 and 70 is contained in the interval found; it is a reasonable conclusion that the district coordinator can be confident in the students’ results this year.
32. a. The 95 percent confidence level means that if one were to repeatedly take random samples of the same size from the population and construct a 95 percent confidence interval from each sample, then in the long run 95 percent of those intervals would succeed in capturing the actual value of the population proportion of households in the county that own at least one dog.

b. No. The 95 percent confidence interval $0.417 \pm 0.119$ is the interval $(0.298, 0.536)$. This interval includes the value $0.39$ as a plausible value for the population proportion of households in the county that own at least one dog. Therefore, the confidence interval does not provide evidence that the proportion of dog owners in this county is different from the claimed national proportion.

c. The sample proportion is $0.417$, and the margin of error is $0.119$. Determining the sample size requires solving the equation $0.119 = 1.96 \sqrt{\frac{(0.417)(1 - 0.417)}{n}}$ for $n$. Thus, $n = \frac{1.96^2(0.417)(1 - 0.417)}{0.119^2} \approx 65.95$, so the humane society must have selected 66 households for its sample.