

BIOS 600-001

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Practice Multiple Choice Questions

Exam 1

Descriptive Statistics

The Environmental Protection Agency records data on the fuel economy of many different makes of cars. Data on the mileage of 20 randomly selected cars are listed below. The values are ordered for convenience.

12	13	15	16	16	17	18	18	19	19
20	20	22	23	24	26	26	27	27	29

1. What is the median mileage for these 20 cars?

- A) 17.5 miles per gallon
- B) 19 miles per gallon
- C) 19.5 miles per gallon
- D) 20 miles per gallon

2. If the value 29 were misrecorded and should really be 21, what would the median mileage be for these 20 cars?

- A) It would change to 20 miles per gallon.
- B) It would stay the same.
- C) It would change to 21 miles per gallon.
- D) We cannot determine this from the given information.

3. What is the interquartile range for the mileage data?

A) 8.5 miles per gallon

B) 16.5 miles per gallon

C) 17 miles per gallon

D) 25 miles per gallon

4. The median age of five people in a meeting is 30 years. One of the people, whose age is 50 years, leaves the room. What is the median age of the remaining four people in the room?

A) 40 years.

B) 30 years.

C) 25 years.

D) This cannot be determined from the information given.

#### Normal Probabilities

5. The time to complete a standardized exam is approximately Normal with a mean of 70 minutes and a standard deviation of 10 minutes. Using the 68-95-99.7 rule, what percentage of students will complete the exam in under an hour?

A) 68%

B) 32%

C) 16%

D) 5%

Chocolate bars produced by a certain machine are labeled with 8.0 oz. The distribution of the actual weights of these chocolate bars is Normal with a mean of 8.1 oz and a standard deviation of 0.1 oz. A chocolate bar is considered underweight if it weighs less than 8.0 oz.

6. What proportion of chocolate bars weighs less than 8.0 oz?

- A) 0.159
- B) 0.341
- C) 0.500
- D) 0.841

7. What proportion of chocolate bars weighs between 8.2 and 8.3 oz?

- A) 0.136
- B) 0.477
- C) 0.636
- D) 0.819

8. How should the chocolate bar wrappers be labeled so that only 1% of such bars are underweight?

- A) 7.77 oz
- B) 7.87 oz
- C) 8.23 oz
- D) 8.33 oz

### Characteristics of Studies

9. Sickle-cell disease is a painful disorder of the red blood cells that in the United States affects mostly African-Americans. To investigate whether the drug hydroxyurea can reduce the pain associated with sickle-cell disease, a study by the National Institutes of Health gave the drug to 150 sickle-cell sufferers and a placebo to another 150. The researchers then counted the number of episodes of pain reported by each subject. What is the response variable in this study?

- A) The drug hydroxyurea.
- B) The number of episodes of pain.
- C) The presence of sickle-cell disease.
- D) The number of red blood cells.

10. Fill in the blank. The participants were given some free time after receiving their drops. The researcher did not keep track of what they did in that free time. It turns out that many of the people receiving the medicine spent their time outside and many of the people receiving the placebo spent their time inside.

The results may now be biased because the variable location (inside vs. outside) is an example of a \_\_\_\_\_ variable.

- A) lurking
- B) confounding
- C) response

### Samples and Populations

A television station is interested in predicting whether or not voters in its listening area are in favor of federal funding for abortions. It asks its viewers to phone in and indicate whether they are in favor of or opposed to this. Of the 2241 viewers who phoned in, 1574 (70.24%) were opposed to federal funding for abortions.

11. Fill in the blank. The number 70.24% is a \_\_\_\_\_

- A) statistic.      C) sample.
- B) parameter.    D) population.

A marketing research firm wishes to determine if the adult men in Laramie, Wyoming, would be interested in a new upscale men's clothing store. From a list of all residential addresses in Laramie, the firm selects a simple random sample of 100 and mails a brief questionnaire to each.

12. What is the population of interest?
- A) All adult men in Laramie, Wyoming.
  - B) All residential addresses in Laramie, Wyoming.
  - C) The members of the marketing firm that actually conducted the survey.
  - D) The 100 addresses to which the survey was mailed.
13. What is the sample in this survey?
- A) All adult men in Laramie, Wyoming.
  - B) All residential addresses in Laramie, Wyoming.
  - C) The members of the marketing firm that actually conducted the survey.
  - D) The 100 addresses to which the survey was mailed.
14. What do we know about the chance that all 100 homes in a particular neighborhood in Laramie end up being the sample of residential addresses that is selected?
- A) It is the same as for any other set of 100 residential addresses.
  - B) It is exactly 0. Simple random samples will spread out the addresses selected.
  - C) It is reasonably large due to the "cluster" effect.
  - D) It is 100 divided by the size of the population of Laramie.

15. Which of the following best describes a simple random sample (SRS) of size  $n$ ?
- A) It is a random sample of size  $n$  selected so that everyone in the population has a known probability of being included in the sample.
  - B) It is a random sample of size  $n$  selected so that everyone in the population has the same chance of being included in the sample.
  - C) It is a probability sample of size  $n$  with known probabilities of selection.
  - D) It is a sample selected from the population in such a way that every set of  $n$  individuals has an equal chance of being the sample actually selected.
  - E) It is a sample of  $n$  individuals selected in such a way that only chance determines who is included in the sample.
16. Suppose several of the units selected into a random sample cannot be found or contacted during the conducting of a survey. What can we say about this situation?
- A) This sample contains a lurking variable.
  - B) This will likely produce nonresponse bias in the sample results.
  - C) The sample results will suffer from response bias.
  - D) This situation came about because of interviewer inefficiency.
  - E) The sample selected is suffering from undercoverage.

### Probability Rules

If you draw an M&M candy at random from a bag of the M&Ms, the candy you draw will have one of six colors. The probability of drawing each color depends on the proportion of each color among all candies made. Assume the table below gives the probabilities for the color of a randomly chosen M&M:

Color	Brown	Red	Yellow	Green	Orange	Blue
Probability	0.3	0.3	?	0.1	0.1	0.1

17. What is the probability of drawing a yellow candy?

- A) 0.1
- B) 0.2
- C) 0.3
- D) Impossible to determine from the information given.

18. What is the probability of not drawing a red candy?

- A) 0.3
- B) 0.6
- C) 0.7
- D) 0.9

19. Event A occurs with probability 0.2. Event B occurs with probability 0.8. If A and B are disjoint (mutually exclusive), then

- A)  $P(A \text{ and } B) = 0.16$
- B)  $P(A \text{ or } B) = 1.0$
- C)  $P(A \text{ and } B) = 1.0$
- D)  $P(A \text{ or } B) = 0.16$

## Random Variables

Suppose a random variable  $X$  is distributed according to the following probability mass function.

Value of $X$	1	2	3	4	5
Probability	0.10	0.25	0.30	0.20	0.15

20. What is  $P(X < 3)$ ?

- A) 0.10    C) 0.35  
B) 0.25    D) 0.65

21. What is  $P(X \leq 3)$ ?

- A) 0.10    C) 0.35  
B) 0.25    D) 0.65

The probability density of a continuous random variable  $X$  is given in the figure below:



22. Based on this density, what is the probability that  $X$  is between 0.5 and 1.5?

- A)  $\frac{1}{3}$     C)  $\frac{3}{4}$   
B)  $\frac{1}{2}$     D) 1

23. What is the  $P(X > 1.5)$ ?

A) 0      C)  $\frac{1}{3}$

B)  $\frac{1}{4}$       D)  $\frac{1}{2}$

24. What is the  $P(X \geq 1.5)$ ?

A) 0      C)  $\frac{1}{3}$

B)  $\frac{1}{4}$       D)  $\frac{1}{2}$

Mean/Variance of RVs

It is estimated that chemotherapy is successful 70% of the time in curing a particular type of cancer. Suppose that 4 patients with the given type of cancer are treated and let  $X$  be the number of them that are successfully cured. The probability mass function of  $X$  is

<u>X</u>	<u>0</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
$P(X = x)$	0.01	0.08	0.27	0.40	0.24

25. What is the expected value of the number of patients that will be cured?

A) 3

B) 2

C) 0.2

D) 2.78

E) 2.5

26. What is the variance of the number of patients that will be cured?

- A) 3.24
- B) 8.6
- C) 2.8
- D) 0.863
- E) 0.2

Sampling Distribution of X-bar

The weights of medium oranges packaged by an orchard are Normally distributed with a mean of 14 oz and a standard deviation of 2 oz.

27. Ten medium oranges will be randomly selected from a package. What is the sampling distribution of the sample mean weight of a random sample of ten medium oranges?

- A)  $N(14, 2)$       C)  $N(14, 0.2)$
- B)  $N(14, 0.63)$       D)  $N(1.4, 0.2)$

28. Suppose a simple random sample is selected from a population with mean  $\mu$  and variance  $\sigma^2$ . The central limit theorem tells us that

- A) the sample mean  $\bar{x}$  gets closer to the population mean  $\mu$  as the sample size increases.
- B) if the sample size  $n$  is sufficiently large, the sample will be approximately Normal.
- C) the mean of  $\bar{x}$  will be  $\mu$  if the sample size  $n$  is sufficiently large.
- D) if the sample size is sufficiently large, the distribution of  $\bar{x}$  will be approximately Normal with mean  $\mu$  and standard deviation,  $\sigma/\sqrt{n}$ .
- E) the distribution of  $\bar{x}$  will be Normal only if the population from which the sample is selected is also Normal.

A population variable has a distribution with mean  $\mu = 50$  and variance  $\sigma^2 = 225$ . From this population a simple random sample of  $n$  observations is to be selected and the mean  $\bar{x}$  of the sample values calculated.

29. How big must the sample size  $n$  be so that the standard deviation of the sample mean,  $\bar{x}$ , is equal to 1.4, i.e.,  $\sigma_{\bar{x}} = 1.4$ ?

- A)  $n = 11$
- B)  $n = 161$
- C)  $n = 115$
- D)  $n = 36$
- E)  $n = 21$

### Confidence Intervals

30. Suppose that the population of the scores of all high school seniors who took the SAT Math (SAT-M) test this year follows a Normal distribution with standard deviation  $\sigma = 100$ . You read a report that says, "On the basis of a simple random sample of 100 high school seniors that took the SAT-M test this year, a confidence interval for  $\mu$  is found to be  $512.00 \pm 25.76$ ." What was the confidence level used to calculate this confidence interval?

- A) 90%
- B) 95%
- C) 99%
- D) 99.9%

An agricultural researcher plants 25 plots with a new variety of yellow corn. Assume that the yield per acre for the new variety of yellow corn follows a Normal distribution with unknown mean  $\mu$  and standard deviation  $\sigma = 10$  bushels per acre.

31. If the average yield for these 25 plots is  $\bar{x} = 150$  bushels per acre what is a 90% confidence interval for  $\mu$ ?

- A)  $150 \pm 0.784$
- B)  $150 \pm 2.00$
- C)  $150 \pm 3.29$
- D)  $150 \pm 3.92$

32. Which of the following would produce a confidence interval with a smaller margin of error than the 90% confidence interval?

- A) Plant only 5 plots rather than 25, because 5 are easier to manage and control.
- B) Plant 10 plots rather than 25, because a smaller sample size will result in a smaller margin of error.
- C) Plant 100 plots rather than 25, because a larger sample size will result in a smaller margin of error.
- D) Compute a 99% confidence interval rather than a 90% confidence interval, because a higher confidence level will result in a smaller margin of error.

The lifetime (in hours) of a 60-watt light bulb is a random variable that has a Normal distribution with  $\sigma = 30$  hours. A random sample of 25 bulbs put on test produced a sample mean lifetime of  $\bar{x} = 1038$  hours.

33. Based on the above information, the 92% confidence interval estimate for the mean lifetime,  $\mu$ , is
- A) (1022.1, 1053.9).
  - B) (1027.5, 1048.5).
  - C) (1026.2, 1049.8).
  - D) (1028.1, 1047.9).
  - E) (1022.5, 1053.5).
34. If it were desired to cut the confidence interval in question 28 to half its length, while keeping the same 92% level, what size sample would be required to achieve this?
- A) 50
  - B) 13
  - C) 75
  - D) 100
  - E) 41

### Hypothesis Tests

35. Is the mean height for all adult American males between the ages of 18 and 21 now over 6 feet? Let  $\mu$  represent the population mean height of all adult American males between the ages of 18 and 21. What are the appropriate null and alternative hypotheses to answer this question?
- A)  $H_0: \mu = 6$  vs.  $H_a: \mu < 6$
  - B)  $H_0: \mu = 6$  vs.  $H_a: \mu \neq 6$
  - C)  $H_0: \mu = 6$  vs.  $H_a: \mu > 6$

36. The test statistic for a two-sided significance test for a population mean is  $z = -2.12$ . What is the corresponding P-value?

- A) 0.017            C) 0.483  
B) 0.034            D) 0.983

37. The test statistic for a significance test for a population mean is  $z = -2.12$ . The hypotheses are  $H_0: \mu = 10$  versus  $H_a: \mu > 10$ . What is the corresponding P-value?

- A) 0.017            C) 0.483  
B) 0.034            D) 0.983

#### Power and Sample Size

38. A medical researcher is working on a new treatment for a certain type of cancer. The average survival time after diagnosis on the standard treatment is two years. In an early trial, she tries the new treatment on three subjects who have an average survival time after diagnosis of four years. Although the survival time has doubled, the results are not statistically significant, even at the 0.10 significance level. Suppose, in fact, that the new treatment does increase the mean survival time in the population of all patients with this particular type of cancer. Which of the following statements is true?

- A) A Type I error has been committed.  
B) A Type II error has been committed.  
C) No error has been committed.

39. An engineer has designed an improved light bulb. The previous design had an average lifetime of 1200 hours. Using a sample of 2000 of these new bulbs, the average lifetime of this improved light bulb is found to be 1201 hours. Although the difference is quite small, the effect was statistically significant at the 0.05 level. Suppose that, in fact, there is no difference between the mean lifetimes of the previous design and the new design. Which of the following statements is true?

- A) A Type I error has been committed.  
B) A Type II error has been committed.  
C) No error has been committed.

A researcher plans to conduct a test of hypotheses at the 1% significance level. She designs her study to have a power of 0.90 at a particular alternative value of the parameter of interest.

40. What is the probability that the researcher will commit a Type I error?

- A) 0.01                      C) 0.90
- B) 0.10                      D) 0.99

41. What is the probability that the researcher will commit a Type II error for the particular alternative value of the parameter at which she computed the power?

- A) 0.01                      C) 0.90
- B) 0.10                      D) 0.99

The attention span of little kids (ages 3–5) is claimed to be Normally distributed with a mean of 15 minutes and a standard deviation of 4 minutes. A test is to be performed to decide if the average attention span of these kids is really this short, or if it is longer. You decide to test the hypotheses  $H_0: \mu = 15$  versus  $H_a: \mu > 15$  at the 5% significance level. A sample of 10 children will watch a TV show they have never seen before, and the time until they walk away from the show will be recorded.

42. If, in fact, the true mean attention span of these kids is 18 minutes, what is the probability of a Type II error?

- A) 0.0107                      C) 0.3405
- B) 0.2335                      D) 0.7665