



TENNESSEE MATHEMATICS TEACHERS ASSOCIATION

SIXTY-SIXTH ANNUAL MATHEMATICS CONTEST

2024

Statistics

Prepared by:

Daniel Inghram
Dyersburg State Community College
Dyersburg, TN

Scoring Formula: $4 \times (\text{Number Right}) - (\text{Number Wrong}) + 40$

Directions:

Do not open this booklet until you are told to do so.

This is a test of your competence in high school mathematics. For each problem, determine the best answer and indicate your choice by making a heavy black mark in the proper place on the separate answer sheet provided. You must use a pencil with a soft lead (No. 2 lead or softer).

This test has been constructed so that most of you are not expected to answer all of the questions. Do your best on the questions you feel you know how to work. You will be penalized for incorrect answers, so wild guesses are not advisable.

If you change your mind about an answer, be sure to erase completely. Do not mark more than one answer for any problem. Make no stray marks of any kind on the answer sheet. The answer sheets will not be returned to you; if you wish a record of your performance, mark your answers in this booklet also. You will keep the booklet after the test is completed.

When told to do so, open your test booklet and begin. You will have exactly eighty minutes to work.

1. On Chess.com, the mean “skill rating” is 1,050 with a standard deviation of 350. For an individual with a skill rating of 680, what is the individual’s z-score?
 - A. 677
 - B. -1.06
 - C. 1.06
 - D. -0.31
 - E. 0.31

2. A local government wants to find the exact number of registered voters in a city. Which method would provide the most accurate and complete data for this purpose?
 - A. Census
 - B. Sample Survey
 - C. Experiment
 - D. Observational Study
 - E. Online Poll

3. Ms. Dani’s math class is studying different types of graphs to display data. She wants to show the relationship between two numerical variables, such as height and weight, for students in her class. Which type of graph should she use to best display this data?
 - A. Scatterplot
 - B. Histogram
 - C. Parallel Box Plots
 - D. Bar Graph
 - E. Pie Chart

4. The scores of students on a history exam were: 35, 45, 60, 60, 60, 70, 75, 80, 85, 90. Which of the following is the best choice for the mean and shape of this distribution?
 - A. Mean: 60, Symmetrical
 - B. Mean: 65, Right-Skewed
 - C. Mean: 66, Right-Skewed
 - D. Mean: 65, Left-Skewed
 - E. Mean: 66, Left-Skewed

5. The chess club has been tracking the number of members attending their weekly meetings. The attendance numbers for the last seven meetings are the following: 15, 14, 16, 80, 17, 15, 16. Which data point is an outlier, and what will be the impact of this outlier on the mean and median of the data?
- A. 15; Increases mean, decreases median.
 - B. 14; Increases mean, no impact on median.
 - C. 80; Increases mean, no impact on median.
 - D. 16; Decreases mean, increases median.
 - E. 80; Decreases mean, no impact on median.
6. In a recent study, it was found that the number of ice cream sales in a town was strongly correlated with the number of people swimming in the town's public pool. Which of the following conclusions is appropriate based on this information?
- A. The increase in ice cream sales causes more people to swim in the pool.
 - B. Correlation does not imply causation, so we cannot determine a cause-and-effect relationship between ice cream sales and the number of people swimming.
 - C. There must be a common underlying factor, such as hot weather, influencing both ice cream sales and the number of people swimming.
 - D. The increase in the number of people swimming in the pool causes an increase in ice cream sales.
 - E. The strong correlation proves that ice cream sales and the number of people swimming are directly connected.
7. In a recent study, the mean salary of all employees in a company was found to be \$60,000. A random sample of 50 employees was taken, and their mean salary was \$58,000 with a standard deviation of \$5,000. Which of the following statements is correct?
- A. The mean salary of the sample is a parameter.
 - B. The standard deviation of the sample is a parameter.
 - C. The mean salary of the population is \$60,000, and this is a statistic.
 - D. The mean salary of the sample is \$58,000, and this is a statistic.
 - E. The standard deviation of the population is \$5,000, and this is a statistic.

8. A researcher wants to determine whether the observed distribution of books read across different grades deviates significantly from what was expected. They conduct a Chi-square test using data contained in the following table.

Table: Number of Books Read by Students in Different Grades (Total Students = 400)

Grade	Expected Number of Books	Observed Number of Books
9th	100	90
10th	100	110
11th	100	95
12th	100	105

Which of the following statements is the most accurate interpretation of the Chi-square test for this data?

- A. The Chi-square test will determine the exact grade level that read the most books.
 - B. The Chi-square test will show that 9th graders read significantly fewer books than other grades.
 - C. The Chi-square test can test whether the observed distribution significantly differs from the expected uniform distribution across grades.
 - D. The Chi-square test will confirm that the average number of books read by all students is 100.
 - E. The Chi-square test will show that the total number of books read by 11th and 12th graders is the same.
9. A study compares the proportion of people who like tea between two different cities, City A and City B. According to the study, a 95% confidence interval for the difference between the proportions is $(-0.04, 0.08)$. Which of the following is the best interpretation?
- A. City A definitively prefers tea more than City B.
 - B. City A definitively prefers tea less than City B.
 - C. There is insufficient evidence to determine whether City A or City B has a greater preference for tea.
 - D. City A and City B have the same preference of tea.
 - E. City A and City B do not have the same preference of tea.
10. In a study of pet ownership, researchers collect data on the type of pet (dog, cat, bird, etc.) and the weight of the pet (in kilograms). What types of variables are these?
- A. Categorical and Measurement
 - B. Univariate and Bivariate
 - C. Measurement and Univariate
 - D. Bivariate and Categorical
 - E. Categorical and Bivariate

11. The height (in inches) of Canadian actresses can be modeled using a normal distribution with mean 64 and standard deviation 2. If a Canadian actress is selected at random, what is the probability they are shorter than 60 inches?
- A. 0.8176
 - B. 0.7414
 - C. 0.1824
 - D. 0.0228
 - E. 0.9772
12. In a specific smartphone store, the probability that a customer buys a smartphone with a large screen is 0.24. Given that a customer chooses a large screen smartphone, the probability that it is a silver model is 0.35. What is the probability that a customer purchases a silver large screen smartphone?
- A. 0.0840
 - B. 0.2450
 - C. 0.3500
 - D. 0.5900
 - E. 0.2400
13. Researchers want to estimate the proportion of Americans who like Brussels sprouts. In a random sample of 500 Americans, 150 said they liked Brussels sprouts. Which is the best choice for a 99% confidence interval for the true proportion?
- A. (0.24721, 0.35279)
 - B. (0.26629, 0.33371)
 - C. (0.25983, 0.34017)
 - D. (0.27374, 0.32626)
 - E. (0.28800, 0.88800)
14. Isabella is picking an outfit for school. She has 3 shirts, 4 pairs of pants, and 2 pairs of shoes to choose from. How many different outfits can Isabella create?
- A. 8
 - B. 24
 - C. 12
 - D. 9
 - E. 15

15. A group of students were asked how many hours they spend on homework each week. The collected data is as follows:

5, 6, 7, 8, 9, 10, 10, 11, 14, 15

What is the Interquartile Range (IQR) for this data?

- A. 7
 - B. 3
 - C. 4
 - D. 6
 - E. 2.5
16. Suppose a fair coin will be flipped 5 times, and the number of heads will be counted. If you receive \$1 for each head and lose \$1 for each tail, what is the expected value of your winnings?
- A. \$0
 - B. \$1
 - C. \$2.5
 - D. \$5
 - E. -\$2.5
17. Lizard Rabbits have height (in cm) that follows a normal distribution with a mean of 40 and a standard deviation of 4. If the sample size is 25, would a sample mean of 42 be unusual?
- A. No, because the z-score is 0.5.
 - B. No, because the z-score is 2.5.
 - C. Yes, because the z-score is 2.5.
 - D. Yes, because the z-score is 0.5.
 - E. Yes, because the z-score is -2.5

18. A school of 300 students is investigating the relationship between students participating in sports and their interest in math. They created the following two-way frequency table:

Table: Math Status vs. Sports Status (Total Students = 300)

	Likes Math	Does Not Like Math	Total
Plays Sports	50	50	100
Doesn't Play Sports	50	150	200
Total	100	200	300

Based on the table, are the events "Likes Math" and "Plays Sports" independent?

- A. Yes, they are independent.
B. No, they are not independent.
C. Cannot determine without more information.
D. There is an equal likelihood of liking or not liking math.
E. More students who do not play sports like math.
19. The school cafeteria is trying to promote healthy eating by selling salads. They notice that for every additional topping added, the number of salads sold increases by 15 per day. When they offer no additional toppings, they still sell 50 salads per day. They create a linear model to represent this pattern, where y is the number of salads sold per day, and x is the number of additional toppings offered. The equation is $\hat{y} = 15x + 50$. Which of the following best interprets the slope and intercept in the context of the data?
- A. Slope: Increase in toppings by 15; Intercept: 50 additional toppings.
B. Slope: 15 additional toppings; Intercept: Increase in sales by 50 salads.
C. Slope: 50 additional toppings; Intercept: Increase in sales by 15 salads
D. Slope: 50 salads sold with no additional toppings; Intercept: Increase in sales by 15 salads for every additional topping.
E. Slope: Increase in sales by 15 salads for every additional topping; Intercept: 50 salads sold with no additional toppings.

20. You are flipping a fair coin, which has a probability of landing heads of $\frac{1}{2}$. According to the Law of Large Numbers, as the number of coin flips increases, which of the following statements is most accurate regarding the proportion of heads?
- A. The proportion of heads will eventually become 0.
 - B. The proportion of heads will always be exactly $\frac{1}{2}$ after every flip.
 - C. The proportion of heads will oscillate between 0 and 1, without settling on any particular value.
 - D. The proportion of heads will converge to $\frac{1}{2}$, but it may not be exactly $\frac{1}{2}$ after any finite number of flips.
 - E. The proportion of heads will eventually become 1.
21. At a bakery, there are three types of treats available: cookies, muffins, and croissants. If A represents the event of choosing a cookie, B represents the event of choosing a muffin, and C represents the event of choosing a croissant, which of the following represents the event of choosing either a cookie or a muffin but not a croissant?
- A. $(A \cup B) \cup C^c$
 - B. $(A \cap B) \cap C^c$
 - C. $(A \cup B) \cap C^c$
 - D. $A^c \cap B^c$
 - E. $(A \cap B) \cup C^c$
22. A researcher has constructed a 95% confidence interval for the average lifespan of outdoor cats. Which of the following statements is correct regarding the interpretation of this 95% confidence interval?
- A. If the researcher takes 100 random samples, exactly 95 of them will contain the true population mean.
 - B. There is a 95% probability that the true population mean falls within the calculated interval.
 - C. The true population mean is 95% likely to fall within this specific interval.
 - D. If the process is repeated and many 95% confidence intervals are constructed from new random samples, 95% of those intervals would contain the true population mean.
 - E. The true population mean is 5% likely to fall outside this specific interval.

23. A researcher wants to test whether a new dietary supplement has an effect on reducing body weight. She conducts a study with a small sample of 4 individuals, using the new supplement for a month. She wants to perform a left-tailed hypothesis test on the mean weight reduction at the 10% significance level. Assuming the sample follows a t-distribution, what is the correct t-value that the researcher should use for this test?
- A. 2.353
 - B. -1.638
 - C. -1.282
 - D. -2.353
 - E. 1.638
24. You are tasked with estimating the mean height of students in a large university based on a random sample. After calculating the mean height from this sample, what does this calculated mean height best exemplify?
- A. A biased estimator.
 - B. A population parameter.
 - C. A point estimator.
 - D. The variability of the sample.
 - E. A guaranteed accurate measure of the mean height of all students in the university.
25. A pharmaceutical company has developed a new drug that claims to effectively reduce high blood pressure. Before approving it, the FDA runs tests to determine if the drug is effective. If the FDA approves the drug when it does not actually work, it would be an error. If they reject the drug when it does work, it would be an error. Which of the following pairs correctly identifies these two errors?
- A. Type I error for approval when not effective; Type II error for rejection when effective.
 - B. Type II error for approval when not effective; Type I error for rejection when effective.
 - C. Type I error for rejection when not effective; Type II error for approval when effective.
 - D. Both scenarios are Type I errors.
 - E. Both scenarios are Type II errors.

26. The body weight of adult greyhound dogs follows a normal distribution with a mean of 68 pounds and a standard deviation of 7 pounds. Suppose you are interested in adopting one, but you require it to be heavier than at least 75% of other adult greyhounds. At a minimum, how much must the greyhound dog weigh? Round your answer to the closest whole pound.
- A. 73
 - B. 75
 - C. 63
 - D. 53
 - E. 39

27. As a part of her research, Dr. Martinez studies the heights of a certain type of tree in a national park. She randomly selects 50 trees and records their heights. The sample mean height is found to be 35 feet. Assume the population standard deviation is 7 feet. Dr. Martinez wants to estimate the mean height of all such trees in the national park with a 95% confidence level. Which of the following represents the 95% confidence interval for the mean height?

- A. (47.68, 52.32)
- B. (24.07, 75.93)
- C. (33.37, 36.63)
- D. (32.45, 37.55)
- E. (33.06, 36.94)

28. A game developer is designing a new online game in which players can earn virtual coins through various tasks. The developer wants to create a balanced economy within the game and is considering the coin rewards for a particular task. The task has five possible outcomes with the following probabilities:

- Completing the task with excellence: 10% (Reward: 50 coins)
- Completing the task with proficiency: 30% (Reward: 30 coins)
- Completing the task adequately: 40% (Reward: 15 coins)
- Failing the task but still receiving a consolation: 15% (Reward: 5 coins)
- Failing the task without any consolation: 5% (Reward: 0 coins)

Given the above information, how would you define the random variable X that represents the reward (in coins) for this task, and what would be its expected value?

- A. $X = \{50, 30, 15, 5, 0\}$ with an expected value of 18.75 coins.
- B. $X = \{10, 30, 40, 15, 5\}$ with an expected value of 23.5 coins.
- C. $X = \{50, 30, 15, 5, 0\}$ with an expected value of 20 coins.
- D. $X = \{0.10, 0.30, 0.40, 0.15, 0.05\}$ with an expected value of 18.75 coins.
- E. $X = \{50, 30, 15, 5, 0\}$ with an expected value of 15 coins.

29. A researcher is interested in studying the effect of a new training program on improving the mile time for high school seniors. He has four options for conducting the study: a randomized controlled trial (RCT), an observational study, a retrospective study, and a survey. Which of the following research designs will allow him to make a causal inference about the effect of the new training program on the seniors' mile time?
- A. Only the observational study.
 - B. Only the randomized controlled trial (RCT).
 - C. Both the randomized controlled trial (RCT) and the observational study.
 - D. Both the randomized controlled trial (RCT) and the retrospective study.
 - E. All four study types.
30. A company has developed a product claiming to remove the jitters caused by math tests in less than 15 minutes. A clinical trial is conducted to test this claim. The null hypothesis is that the mean time to remove the jitters, μ , is equal to 15 minutes, and the alternative hypothesis is that μ is not equal to 15 minutes. If the p-value of the two-tailed hypothesis test is 0.04 and the significance level is 0.05, which of the following statements is correct?
- A. Reject the null hypothesis; there is enough evidence to conclude that the mean time to remove jitters is not 15 minutes.
 - B. Fail to reject the null hypothesis; there is not enough evidence to support the company's claim.
 - C. Reject the null hypothesis; there is enough evidence to support the company's claim that the mean time is exactly 15 minutes.
 - D. Reject the null hypothesis; there is enough evidence to support the company's claim that the mean time is less than 15 minutes.
 - E. Fail to reject the null hypothesis; the test is inconclusive.
31. Which of the following statements describes why the Central Limit Theorem is considered a fundamental concept in statistics?
- A. It claims that for a large enough sample size, the population itself becomes approximately normal.
 - B. It states that for a large enough sample size, the sampling distribution of the sample mean is approximately normal, regardless of the population distribution.
 - C. It asserts that for any sample size, the sampling distribution of the sample mean will always be approximately normal.
 - D. It posits that for any population distribution, the sampling distribution of the sample mean is approximately normal, regardless of the sample size.
 - E. It insists that for any sample size and population distribution, the median will follow an approximately normal distribution.

32. A researcher wants to study the impact of a required chess-in-schools program on students' performance in schools across a large country. The country is divided into different states, each state having various districts, and each district having several schools. The researcher has limited time and resources. Which of the following sampling methods would be the most appropriate to ensure that the sample represents different regions without consuming too many resources?
- A. Simple Random Sampling from all schools in the country
 - B. Stratified Random Sampling, with states as strata
 - C. Stratified Random Sampling, with individual students as strata
 - D. Cluster Sampling, selecting random states, then random districts within those states
 - E. Cluster Sampling, selecting random schools from each state
33. A space exploration team consists of eight astronauts, including four specialists named Apollo, Buzz, Callisto, and Draco. The mission commander needs to select an elite crew of four astronauts for a special mission to Mars. What is the probability that Apollo, Buzz, Callisto, and Draco are the four astronauts chosen for this special mission?
- A. $\frac{1}{2}$
 - B. $\frac{1}{35}$
 - C. $\frac{1}{280}$
 - D. $\frac{1}{140}$
 - E. $\frac{1}{70}$
34. A student takes a multiple-choice test that has 5 questions. Each question has four choices. If the student guesses randomly at each answer, which is the best choice for the probability of answering at least 2 questions correctly?
- A. 0.104
 - B. 0.410
 - C. 0.590
 - D. 0.367
 - E. 0.633

35. Researchers conducted an experiment to determine the effect of a new nutritional supplement on enhancing memory in adults. They randomly assigned half of the participants to the treatment group (receiving the supplement) and the other half to the control group (receiving a placebo). However, participants in the treatment group were also provided with weekly memory-enhancing training sessions, while the control group was not. Based on this experimental setup, which of the following statements correctly describes the role of experimental control and its effect on confounding?
- A. The memory-enhancing training sessions for the treatment group ensured that any memory improvement was due to the supplement.
 - B. The introduction of the memory-enhancing training sessions makes it impossible to determine if memory improvements were due to the supplement or the training sessions.
 - C. The random assignment of participants to the treatment and control groups eliminated all potential confounding variables.
 - D. The control group receiving a placebo ensured that the treatment group's results were solely due to the nutritional supplement.
 - E. Since both groups were part of an experiment, there is no possibility of confounding variables affecting the results.
36. You are considering two automobile insurance policies for your new car. Policy A has a low deductible of \$200 but costs \$1200 per year. Policy B has a high deductible of \$800 but costs only \$800 per year. You estimate that there is a 10% chance you will have an accident in a given year, requiring you to pay the deductible. Given this information, which policy has the better expected value?
- A. Policy A has a lower expected value; hence it is the better option.
 - B. Policy B has a lower expected value; hence it is the better option.
 - C. Both policies have the same expected value; hence either option is equally good.
 - D. The expected value cannot be determined without knowing the exact amount of the deductible.
 - E. The expected value cannot be determined without knowing the total value of the car.

37. A research team is conducting a study on the average height of sunflowers in a particular region. They select 50 random samples of sunflowers, each with 30 sunflowers, and calculate the average height for each sample. Which of the following statements is most accurate concerning the sampling distribution of the sample mean height, and the standard error in this context?
- A. The sampling distribution of the sample mean will be skewed, and the standard error is equal to the population standard deviation.
 - B. The sampling distribution of the sample mean will be approximately normal, and the standard error is equal to the population variance divided by the sample size.
 - C. The sampling distribution of the sample mean will be approximately normal, and the standard error is equal to the sample standard deviation divided by the square root of the sample size.
 - D. The sampling distribution of the sample mean will be uniform, and the standard error is equal to the sample standard deviation divided by the population size.
 - E. The sampling distribution of the sample mean will be approximately normal, and the standard error is equal to the sample variance divided by the sample size.
38. Mr. Bunny, a math teacher, is curious about the relationship between the number of carrots his students eat and their performance on math tests. He records the number of carrots consumed by six students in a week and their corresponding math test scores:

Table: Number of Carrots (x) vs. Math Test Score (y)

Number of Carrots (x)	Math Test Score (y)
5	50
8	75
2	40
10	90
4	45
7	70

Using this data, which of the following best represents the linear regression equation that Mr. Bunny wants to create?

- A. $\hat{y} = 6.51x + 22.58$
- B. $\hat{y} = 6.67x + 21.67$
- C. $\hat{y} = 22.58x + 6.51$
- D. $\hat{y} = 22.58 - 6.67x$
- E. $\hat{y} = 21.67x + 6.67$

39. You are conducting a hypothesis test for the mean weight of apples in a large orchard. The null hypothesis states that the mean weight is 150 grams, and you select a 5% significance level for the test. After collecting a sample and performing the necessary calculations, you find a p-value of 0.042. Which of the following interpretations of this p-value is correct?

- A. If the null hypothesis is true, there is a 4.2% chance that the mean weight of apples in the orchard is 150 grams.
- B. There is a 4.2% chance that the null hypothesis is true.
- C. If the null hypothesis is true, there is a 4.2% chance of obtaining a sample mean at least as extreme as the one observed, or more extreme.
- D. The probability that the mean weight of apples in the orchard is 150 grams is 4.2%.
- E. If the alternative hypothesis is true, there is a 4.2% chance of obtaining a sample mean at least as extreme as the one observed, or more extreme.

40. Recently the Journal of the American Vampire Association (JAVA) published an article exploring vampires with Type A blood vs. vampires with Type B blood. In terms of body temperature (in degrees F), Type A have a mean of 44 with a standard deviation of 11 while Type B have a mean of 36 with a standard deviation of 13.

Which of the following statements are true?

- I. Type B are warmer on average than Type A.
 - II. Type A temperatures are more predictable than Type B temperatures.
 - III. Type B temperatures are more variable than Type A temperatures.
- A. I only
 - B. II only
 - C. III only
 - D. I and II
 - E. II and III