

1. How many ways can you arrange the letters in the word "COMBINATORICS"?

- a) 12!
- b) 13!
- c) 14!
- d) 11!

(Correct Answer: a)

2. In how many ways can you choose a president, vice-president, and secretary from a group of 10 people?

- a) 100
- b) 720
- c) 210
- d) 30

(Correct Answer: b)

3. How many 4-digit numbers can be formed using the digits 1, 2, 3, and 4 without repetition?

- a) 12
- b) 24
- c) 64
- d) 256

(Correct Answer: b)

4. A pizza parlor offers 5 different toppings. How many different pizzas can you order with exactly 3 toppings on each?

- a) 15
- b) 10
- c) 5
- d) 20

(Correct Answer: d)

5. How many ways can you arrange the letters in the word "BOOKKEEPER"?

- a) 10!
- b) 11!
- c) 9!
- d) 12!

(Correct Answer: c)

Graph Theory:

6. In graph theory, a connected graph with no cycles is called a:

- a) Tree
- b) Forest
- c) Path
- d) Loop

(Correct Answer: a)

7. How many edges does a complete graph with n vertices have?

- a) n
- b) $n - 1$
- c) $n(n-1)/2$
- d) n^2

(Correct Answer: c)

8. In a bipartite graph, the vertices can be divided into how many disjoint sets?

- a) 1
- b) 2
- c) 3
- d) It depends on the number of edges.

(Correct Answer: b)

9. The minimum number of colors required to color the vertices of a planar graph without any adjacent vertices having the same color is known as:

- a) Chromatic number
- b) Clique number
- c) Chromatic index
- d) Edge coloring

(Correct Answer: a)

10. In graph theory, a cycle of length 3 is called a:

- a) Path
- b) Loop
- c) Triangle
- d) Circuit

(Correct Answer: c)

11. What is the smallest prime number?

- a) 1
- b) 2
- c) 3
- d) 0

(Correct Answer: b)

12. Which of the following numbers is a perfect square?

- a) 36
- b) 48
- c) 53
- d) 64

(Correct Answer: a)

13. What is the largest common divisor of 24 and 36?

- a) 12
- b) 6
- c) 8
- d) 4

(Correct Answer: a)

14. What is the smallest common multiple of 7 and 9?

- a) 63
- b) 72
- c) 45
- d) 18

(Correct Answer: a)

15. Which of the following numbers is a prime number?

- a) 27
- b) 31
- c) 48
- d) 57

(Correct Answer: b)

Geometry and Optimization:

16. What is the sum of the interior angles of a triangle?

- a) 90 degrees
- b) 180 degrees
- c) 270 degrees
- d) 360 degrees

(Correct Answer: b)

17. The area of a square with a side length of 5 units is:

- a) 10 square units
- b) 15 square units
- c) 20 square units
- d) 25 square units

(Correct Answer: d)

18. In a right-angled triangle, the side opposite the right angle is called the:

- a) Hypotenuse
- b) Adjacent side
- c) Opposite side
- d) None of the above

(Correct Answer: a)

19. What is the maximum volume of a rectangular box with a fixed surface area of 96 square units?

- a) 64 cubic units
- b) 128 cubic units
- c) 256 cubic units
- d) 512 cubic units

(Correct Answer: b)

20. The perimeter of a regular hexagon with a side length of 4 units is:

- a) 8 units
- b) 12 units
- c) 16 units
- d) 24 units

(Correct Answer: d)

Sudoku Puzzles:

21. In a standard Sudoku grid, how many rows and columns are there in total?

- a) 6
- b) 9
- c) 12

d) 16

(Correct Answer: b)

22. How many 3x3 regions are there in a standard Sudoku grid?

a) 6

b) 9

c) 12

d) 16

(Correct Answer: b)

23. What is the minimum number of clues needed to ensure a unique solution for a Sudoku puzzle?

a) 20

b) 25

c) 17

d) 30

(Correct Answer: c)

24. In a Sudoku puzzle, what is the range of possible values that can be placed in each cell?

a) 1 to 6

b) 1 to 8

c) 1 to 9

d) 1 to 10

(Correct Answer: c)

25. In a solved Sudoku grid, each row, column, and 3x3 region contains:

a) All even numbers

b) All odd numbers

c) All prime numbers

d) All digits from 1 to 9

(Correct Answer: d)

1. What is the length of the string "hello"?

a) 4

b) 5

c) 6

d) 7

(Correct Answer: b)

2. Which of the following is NOT a string operation?

a) Concatenation

b) Subtraction

c) Length

d) Substring

(Correct Answer: b)

3. The number of characters in the English alphabet is:

a) 26

b) 24

c) 28

d) 30

(Correct Answer: a)

4. An empty string is also known as a:

- a) Null string
- b) Void string
- c) Blank string
- d) Empty character

(Correct Answer: a)

5. How many distinct characters are there in the string "abracadabra"?

- a) 6
- b) 7
- c) 8
- d) 9

(Correct Answer: b)

Combinations:

6. How many ways can a committee of 3 people be formed from a group of 10 people?

- a) 27
- b) 90
- c) 120
- d) 210

(Correct Answer: c)

7. The value of nCn (n choose n) is equal to:

- a) 0
- b) 1
- c) n
- d) n!

(Correct Answer: b)

8. In how many ways can you arrange the letters of the word "APPLE"?

- a) 60
- b) 120
- c) 720
- d) 24

(Correct Answer: d)

9. How many combinations are there of 5 cards drawn from a standard deck of 52 cards?

- a) 10
- b) 78
- c) 259
- d) 2,598,960

(Correct Answer: d)

10. The value of $nCr + nC(r-1)$ is equal to:

- a) nCr
- b) $nCr + 1$
- c) $nC(r+1)$
- d) $n+1$

(Correct Answer: c)

11. Combinatorial refers to the study of:

- a) Permutations and combinations
- b) Algebraic structures
- c) Complex numbers
- d) Trigonometry

(Correct Answer: a)

12. How many anagrams can be formed using the letters of the word "MISSISSIPPI"?

- a) 34650
- b) 2520
- c) 720
- d) 5040

(Correct Answer: b)

13. The number of ways to arrange the letters in the word "COMBINE" such that vowels come together is called:

- a) Combination
- b) Permutation
- c) Restriction
- d) Conjunction

(Correct Answer: c)

14. How many three-digit numbers can be formed using the digits 1, 2, 3, and 4, without repetition?

- a) 6
- b) 12
- c) 24
- d) 10

(Correct Answer: c)

15. The number of ways to choose a president and a vice-president from a group of 10 people is an example of:

- a) Permutation
- b) Combination
- c) Multinomial coefficient
- d) Binomial coefficient

(Correct Answer: a)

16. Binomial coefficients find applications in:

- a) Probability
- b) Geometry
- c) Trigonometry
- d) Integration

(Correct Answer: a)

17. The expansion of $(a + b)^n$ is given by:

- a) $a^n + b^n$
- b) $a^{(n-1)} + b^{(n-1)}$
- c) $a^n - b^n$
- d) $nC_0 * a^n + nC_1 * a^{(n-1)} * b + \dots + nC_n * b^n$

(Correct Answer: d)

18. The Pascal's triangle represents:
- a) The expansion of a binomial expression
 - b) The Fibonacci sequence
 - c) The sum of two binomials
 - d) The multiplication of two binomials
- (Correct Answer: a)

19. Which of the following is equivalent to $5C_2$?
- a) 15
 - b) 20
 - c) 7
 - d) 10
- (Correct Answer: d)

20. The binomial coefficient nC_n is equal to:
- a) n
 - b) $n+1$
 - c) 1
 - d) 0
- (Correct Answer: c)

21. The binomial coefficient nC_k can also be written as:
- a) $n! / (n-k)!$
 - b) $n! / k!$
 - c) $(n+k)! / (n-k)!$
 - d) $(n+k)! / n!$
- (Correct Answer: a)

22. In the multinomial coefficient formula, what does the expression $(n_1+n_2+\dots+n_k)!$ represent?
- a) Sum of all n values
 - b) Product of all n values
 - c) Factorial of the sum of all n values
 - d) Number of combinations
- (Correct Answer: c)

23. The multinomial coefficient $(n; k_1, k_2, \dots, k_m)$ is used to count the number of ways to:
- a) Arrange n distinct elements
 - b) Choose k elements from n elements
 - c) Distribute n objects into m distinct boxes
 - d) Calculate the sum of n and m
- (Correct Answer: c)

24. The multinomial coefficient $(7; 2, 3, 2)$ is equal to:
- a) 210
 - b) 280
 - c) 420
 - d) 1260
- (Correct Answer: b)

25. The multinomial coefficient $(n; n, n, n)$ is equal to:

- a) $n!$
 - b) n^n
 - c) $n^{(3n)}$
 - d) $(3n)! / n!$
- (Correct Answer: d)

1. Mathematical induction is based on the principle of proving a statement for:

- a) A specific case
 - b) All possible cases
 - c) An odd number of cases
 - d) An even number of cases
- (Correct Answer: b)

2. The first step in a proof by induction is to verify the statement for which of the following?

- a) $n = 1$
 - b) $n = 0$
 - c) $n = -1$
 - d) $n = 2$
- (Correct Answer: a)

3. Which of the following is NOT a common method of proof in mathematics?

- a) Direct proof
 - b) Indirect proof
 - c) Backward induction
 - d) Mathematical induction
- (Correct Answer: c)

4. The process of mathematical induction is often used to prove statements about:

- a) Negative integers
 - b) Fractions
 - c) Infinite sets
 - d) Complex numbers
- (Correct Answer: c)

5. Mathematical induction is closely related to which branch of mathematics?

- a) Geometry
 - b) Number theory
 - c) Trigonometry
 - d) Algebra
- (Correct Answer: b)

6. The well-ordering principle states that every non-empty set of positive integers has a:

- a) Smallest element
 - b) Largest element
 - c) Median element
 - d) Prime element
- (Correct Answer: a)

7. Which of the following sets violates the well-ordering principle?

- a) $\{1, 2, 3, 4, 5\}$
- b) $\{2, 4, 6, 8, 10\}$

- c) {3, 6, 9, 12, 15}
 - d) {1, 3, 5, 7, 9}
- (Correct Answer: b)

8. The well-ordering principle is a fundamental property of which number system?

- a) Natural numbers
 - b) Rational numbers
 - c) Real numbers
 - d) Complex numbers
- (Correct Answer: a)

9. The well-ordering principle is equivalent to which principle used in mathematical induction?

- a) Base case
 - b) Inductive step
 - c) Strong induction
 - d) Weak induction
- (Correct Answer: d)

10. The well-ordering principle is also known as the:

- a) Principle of finite sets
 - b) Axiom of choice
 - c) Pigeonhole principle
 - d) Euclidean algorithm
- (Correct Answer: b)

11. In a mathematical statement, the antecedent and consequent are connected by:

- a) Addition
 - b) Subtraction
 - c) Multiplication
 - d) Implication
- (Correct Answer: d)

12. Which of the following statements is a conditional statement?

- a) " $x + 1 = 4$ "
 - b) " $2 + 2 = 5$ "
 - c) "If n is even, then $n + 1$ is odd."
 - d) " $n^2 = n * n$ "
- (Correct Answer: c)

13. The negation of the statement "All birds can fly" is:

- a) "No birds can fly"
 - b) "Some birds cannot fly"
 - c) "All birds cannot fly"
 - d) "Some birds can fly"
- (Correct Answer: b)

14. The statement " $p \rightarrow q$ " is false only when:

- a) Both p and q are true
- b) Both p and q are false
- c) p is false and q is true
- d) p is true and q is false

(Correct Answer: d)

15. Which of the following is an example of a biconditional statement?

- a) "If n is odd, then n^2 is odd."
- b) " $n + 3 = 7$ "
- c) " n is prime if and only if n has exactly two distinct positive divisors."
- d) " n is even or n is odd."

(Correct Answer: c)

16. The expression $(a + b)^n$ is expanded using which coefficients?

- a) Binomial coefficients
- b) Multinomial coefficients
- c) Fibonacci coefficients
- d) Factorial coefficients

(Correct Answer: a)

17. The binomial coefficient nCk represents the number of ways to choose:

- a) k elements from a set of n elements
- b) n elements from a set of k elements
- c) n sets from a set of k elements
- d) k sets from a set of n elements

(Correct Answer: a)

18. Which of the following is equivalent to $7C4$?

- a) 35
- b) 84
- c) 210
- d) 12

(Correct Answer: a)

19. The expression for the binomial coefficient nCk is given by:

- a) $k!(n - k)!$
- b) $n! / (n - k)!$
- c) $n! / k!$
- d) $n!(n - k)!$

(Correct Answer: b)

20. In the expansion of $(a + b)^n$, the sum of the exponents of a and b is equal to:

- a) $n - 1$
- b) n
- c) $2n$
- d) $n + 1$

(Correct Answer: b)

21. The process of solving a problem by breaking it down into smaller, similar subproblems is called:

- a) Recursion
- b) Iteration
- c) Backtracking
- d) Factorization

(Correct Answer: a)

22. The recursive step in solving a combinatorial problem involves:

- a) Dividing the problem into smaller subproblems
- b) Solving the base case directly
- c) Finding a closed-form expression for the solution
- d) Using the well-ordering principle

(Correct Answer: a)

23. Pascal's Triangle is a classic example of a combinatorial problem solved recursively. It is used to calculate:

- a) Factorials
- b) Binomial coefficients
- c) Fibonacci sequence
- d) Prime numbers

(Correct Answer: b)

24. How many paths are there from the top-left corner to the bottom-right corner of a 3x3 grid, moving only right or down?

- a) 3
- b) 6
- c) 9
- d) 12

(Correct Answer: c)

25. In a recursive algorithm, what is

the base case for a combinatorial problem?

- a) The smallest subproblem that can be solved directly
- b) The largest subproblem that can be solved directly
- c) The average of all subproblems
- d) The sum of all subproblems

(Correct Answer: a)

26. Mathematical induction is used to prove statements that are:

- a) False
- b) True for a specific case
- c) True for all positive integers
- d) True for some positive integers

(Correct Answer: c)

27. In the principle of mathematical induction, the step of proving that $P(k) \rightarrow P(k+1)$ is called the:

- a) Base case
- b) Inductive step
- c) Recursive step
- d) Backtracking step

(Correct Answer: b)

28. The inductive hypothesis assumes that $P(k)$ is true for some positive integer k . What is the next step in the induction process?

- a) Proving that $P(k)$ is true for all positive integers
- b) Proving that $P(k+1)$ is true
- c) Proving that $P(k) \rightarrow P(k-1)$

d) Proving that $P(k) \rightarrow P(1)$

(Correct Answer: b)

29. The principle of mathematical induction is based on which axiom or property?

a) Commutative property

b) Distributive property

c) Well-ordering principle

d) Associative property

(Correct Answer: c)

30. Mathematical induction can be used to prove statements about which of the following mathematical structures?

a) Sets

b) Graphs

c) Equations

d) Functions

(Correct Answer: a)

31. An inductive definition defines a sequence of objects or values starting from a:

a) Finite set

b) Recursive case

c) Base case

d) Constant value

(Correct Answer: c)

32. The Fibonacci sequence is defined inductively as follows: $F(0) = 0$, $F(1) = 1$, and $F(n) = F(n-1) + F(n-2)$ for $n \geq 2$. What is the 7th term in the Fibonacci sequence?

a) 5

b) 8

c) 13

d) 21

(Correct Answer: c)

33. An inductive definition of a set starts with a base case and uses which operation to generate other elements?

a) Union

b) Intersection

c) Addition

d) Iteration

(Correct Answer: d)

34. An inductive definition of a tree starts with a base case of a single node and adds which component in each step?

a) Edges

b) Vertices

c) Leaves

d) Branches

(Correct Answer: a)

35. An inductive definition is often used in which area of computer science?

a) Networking

- b) Operating systems
 - c) Artificial intelligence
 - d) Algorithm design
- (Correct Answer: d)

36. Which step in a proof by induction is used to establish the base case?

- a) Step 1
- b) Step 2
- c) Step 3
- d) Step 4

(Correct Answer: a)

37. In a proof by induction, the inductive hypothesis assumes that $P(k)$ is true for some positive integer k . What is the next step in the induction process?

- a) Proving that $P(k)$ is true for all positive integers
- b) Proving that $P(k+1)$ is true
- c) Proving that $P(k) \rightarrow P(k-1)$
- d) Proving that $P(k) \rightarrow P(1)$

(Correct Answer: b)

38. The principle of mathematical induction is based on the well-ordering principle, which states that every non-empty set of positive integers has a:

- a) Smallest element
- b) Largest element
- c) Median element
- d) Prime element

(Correct Answer: a)

39. Which step in a proof by induction is used to prove the inductive step, $P(k) \rightarrow P(k+1)$?

- a) Step 1
- b) Step 2
- c) Step 3
- d) Step 4

(Correct Answer: c)

40. A proof by induction is often used to establish properties of:

- a) Rational numbers
- b) Real numbers
- c) Complex numbers
- d) Positive integers

(Correct Answer: d)

41. Strong induction is a variation of mathematical induction that assumes:

- a) $P(k)$ is true for some positive integer k
- b) $P(k)$ is true for all positive integers less than or equal to k
- c) $P(i)$ is true for all positive integers i up to k
- d) $P(j)$ is true for some positive integer j greater than k

(Correct Answer: c)

42. In a proof by strong induction, the base case involves proving that $P(1)$ is true and also that $P(2)$ is true. This is because:

- a) Strong induction requires two base cases
 - b) The well-ordering principle requires two base cases
 - c) The inductive step requires two base cases
 - d) $P(1)$ and $P(2)$ are equivalent
- (Correct Answer: b)

43. Strong induction is particularly useful when the inductive step requires the assumption of more than one previous case to establish $P(k+1)$. This is also known as:

- a) Backward induction
 - b) Forward induction
 - c) Inductive step
 - d) The pigeonhole principle
- (Correct Answer: c)

44. In a proof by strong induction, what is the next step after proving the base case?

- a) Proving the inductive step, $P(k) \rightarrow P(k+1)$
 - b) Proving that $P(k)$ is true for all positive integers up to k
 - c) Proving the inductive step, $P(k-1) \rightarrow P(k)$
 - d) Proving that $P(k+1)$ is true for all positive integers k
- (Correct Answer: a)

45. The principle of strong induction is based on which axiom or property?

- a) Commutative property
 - b) Distributive property
 - c) Well-ordering principle
 - d) Associative property
- (Correct Answer: c)

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- a) Binomial coefficients
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 - c) Fibonacci coefficients
 - d) Factorial coefficients
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- a) k elements from a set of n elements
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 - c) n sets from a set of k elements
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- a) $k!(n - k)!$

b) $n! / (n - k)!$

c) $n! / k!$

d) $n!(n - k)!$

(Correct Answer: b)

50. In the expansion of $(a + b)^n$, the sum of the exponents of a and b is equal to:

a) $n - 1$

b) n

c) $2n$

d) $n + 1$

(Correct Answer: b)