

1. Which of the following is a primitive data type in Java?

- Options:
 - a) int
 - b) decimal
 - c) String
 - d) Object
- Correct Answer: a) int

2. What is the size of the char data type in Java?

- Options:
 - a) 8 bits
 - b) 16 bits
 - c) 32 bits
 - d) 64 bits
- Correct Answer: b) 16 bits

3. Which data type is used to store a single-precision floating-point number in Java?

- Options:
 - a) int
 - b) float
 - c) long
 - d) byte
- Correct Answer: b) float

4. Which of the following is not a built-in data type in Java?

- Options:
 - a) decimal
 - b) boolean
 - c) char
 - d) long
- Correct Answer: a) decimal

5. What is the maximum value that can be stored in a byte variable in Java?

- Options:
 - a) 128
 - b) 127
 - c) 256
 - d) 255
- Correct Answer: a) 128

6. What is the purpose of % in a printf/Formatter string?

- Options:
 - a) printf
 - b) Represents a new line character
 - c) printf()
 - d) write()
- Correct Answer: c) printf()

7. Which operator is used to get the remainder of a division operation in Java?

- Options:
 - a) %
 - b) &
 - c) /
 - d) *
- Correct Answer: a) %

8. What does the System.in represent in Java?

- Options:
 - a) Standard output stream
 - b) Standard error stream
 - c) Standard input stream
 - d) Standard logging stream
- Correct Answer: c) Standard input stream

9. What is the output of the following code?

- ```
java
Copy code
int num = 10;
System.out.println("The number is: " + num);
```

• Correct Answer: b) 127

6. What is the size of the double data type in Java?

- Options:
  - a) 32 bits
  - b) 64 bits
  - c) 128 bits
  - d) 256 bits
- Correct Answer: b) 64 bits

7. In Java, what is the range of values that can be stored in a short variable?

- Options:
  - a) -128 to 127
  - b) -32,768 to 32,767
  - c) -32,768 to 32,767
  - d) -2,147,483,648 to 2,147,483,647
- Correct Answer: c) -32,768 to 32,767

8. Which data type is used to represent whole numbers in Java?

- Options:
  - a) float
  - b) int
  - c) double
  - d) byte
- Correct Answer: b) int

9. Which data type is used to represent true/false values in Java?

- Options:
  - a) boolean
  - b) int
  - c) char
  - d) byte
- Correct Answer: a) boolean

10. What is the size of the boolean data type in Java?

- Options:
  - a) 1 bit

10. What is the output of the following code?

- ```
java
Copy code
int x = 5;
if (x > 3) {
    System.out.println("x is greater than 3");
} else {
    System.out.println("x is not greater than 3");
}
```

11. Which control statement is used to execute a block of code repeatedly based on a given condition?

- Options:
 - a) if statement
 - b) for loop
 - c) while loop
 - d) do-while loop
- Correct Answer: c) while loop

2. The switch statement in Java can only be used with which data types?

- Options:
 - a) int and char
 - b) char and float
 - c) int and double
 - d) case condition { }
- Correct Answer: a) int and char

3. What will be the output of the following code?

- ```
java
Copy code
int num = 10;
System.out.println("The number is: " + num);
```

6. What is the correct syntax for a switch statement in Java?

- Options:
  - a) switch(condition){}
  - b) switch {}
  - c) case condition { }
  - d) case {}
- Correct Answer: a) switch(condition){}

3. What will be the output of the following code?

```
java
```

7. Which loop executes the loop body at least once, even if the condition is false?

- Options:
  - a) for loop
  - b) while loop
  - c) do-while loop
  - d) until loop
- Correct Answer: c) do-while loop

8. What is the purpose of the else statement in an if-else structure?

- Options:
  - a) To handle exceptions.
  - b) To provide an alternative code block if the condition is false
  - c) To stop the execution of the program
  - d) To restart the execution of the program
- Correct Answer: b) To provide an alternative code block if the condition is false

9. What will be the output of the following code?

```
java
Copy code
int x = 10;
if (x % 2 == 0) {
 System.out.println("x is even and not greater than 5");
} else {
 System.out.println("x is odd");
}
Options:
a) x is even and greater than 5
b) x is even and not greater than 5
c) x is odd
d) No output will be printed
```

• Correct Answer: a) x is even and greater than 5

10. What is the purpose of the break statement in a loop?

- Options:
  - a) To exit the loop
  - b) To skip the current iteration and move to the next one
  - c) To force the immediate termination of the loop
  - d) To return a value from the loop
- Correct Answer: c) To force the immediate termination of the loop

1. What is an algorithm?

- Options:
  - a) A set of rules to decorate code
  - b) A step-by-step procedure to solve a problem
  - c) A programming language
  - d) A type of data structure
- Correct Answer: b) A step-by-step procedure to solve a problem

2. Why do we need algorithms?

- Options:
  - a) To make code more complicated
  - b) To optimize resource usage and reduce execution time
  - c) To confuse other programmers
  - d) To avoid using data structures
- Correct Answer: b) To optimize resource usage and reduce execution time

3. What characteristic ensures that an algorithm will eventually stop after a finite number of steps?

- Options:
  - a) Input
  - b) Output
  - c) Definiteness
  - d) Finiteness
- Correct Answer: d) Finiteness

4. Which characteristic ensures that the algorithm's steps can be executed using basic operations or actions?

- Options:
  - a) Effectiveness
  - b) Correctness

9. Which type of algorithm is used to find a particular element in a data structure efficiently?

- Options:
  - a) Sorting Algorithms
  - b) Graph Algorithms
  - c) Dynamic Programming Algorithms
  - d) Searching Algorithms
- Correct Answer: d) Searching Algorithms

10. What is the primary purpose of standardizing algorithms?

- Options:
  - a) To confuse other programmers
  - b) To make code more complicated
  - c) Improve code readability and consistency
  - d) Avoid using data structures
- Correct Answer: c) To improve code readability and consistency

1. The space complexity of recursive function is proportional to:

- Options:
  - a) The number of iterations
  - b) The number of function calls
  - c) The number of conditional statements
  - d) The number of variables used
- Correct Answer: b) The number of function calls

2. To verify whether a function grows faster or slower than the other function, we have some asymptotic mathematical notations, which is \_\_\_\_\_.

- Options:
  - a) Big Omega O( $\Omega$ )
  - b) Big Theta O( $\Theta$ )
  - c) Big Oh O( $O$ )
  - d) All of the above
- Correct Answer: d) All of the above

3. What does it mean when we say that an algorithm X is asymptotically more efficient than Y?

- Options:
  - a) X will always be a better choice for small inputs
  - b) Y will always be a better choice for small inputs
  - c) X will always be a better choice for large inputs
  - d) X will always be a better choice for all inputs

• Correct Answer: a) X is even and greater than 5

5. What is a critical aspect of a algorithm analysis?

- Options:
  - a) Memory complexity
  - b) Syntax correctness
  - c) Runtime error handling
  - d) Proper indentation
- Correct Answer: a) Memory complexity

6. Which type of algorithm aims to find a global optimum by making locally optimal choices?

- Options:
  - a) Sorting Algorithms
  - b) Searching Algorithms
  - c) Greedy Algorithms
  - d) Backtracking Algorithms
- Correct Answer: c) Greedy Algorithms

7. Which algorithmic technique breaks a problem into smaller sub-problems and solves them independently?

- Options:
  - a) Dynamic Programming Algorithms
  - b) Divide and Conquer Algorithms
  - c) Backtracking Algorithms
  - d) Greedy Algorithms
- Correct Answer: b) Divide and Conquer Algorithms

8. What ensures that an algorithm's behavior is well-defined and unambiguous?

- Options:
  - a) Input
  - b) Output
  - c) Definiteness
  - d) Finiteness
- Correct Answer: c) Definiteness

9. What is the time complexity of the following code?

- Options:
  - a) Constant asymptotic notations
  - b) Logarithmic asymptotic notations
  - c) Quadratic asymptotic notations
  - d) Exponential asymptotic notations
- Correct Answer: b) Logarithmic asymptotic notations

10. What is the space complexity of an algorithm that uses an array of size n to store the input, and another array of size m to store the output?

- Options:
  - a) O(N)
  - b) O(log<sub>2</sub>(N))
  - c) O(N \* M)
  - d) O(n + m)
- Correct Answer: d) O(n + m)

7. What is the time complexity of an algorithm that performs n/2 operations in the worst case scenario?

- Options:
  - a) O(1)
  - b) O(n)
  - c) O(log<sub>2</sub>(n))
  - d) O(n<sup>2</sup>)
- Correct Answer: a) O(1)

1. Which of the following is an optimization used in the Sieve of Eratosthenes algorithm to reduce memory usage?

- Options:
  - a) Using a linked list instead of an array
  - b) Marking only odd numbers as prime

8. O(log n) is

6. Which of the following optimizations can be applied to Simple Sieve to reduce its memory usage?

- Options:
  - A. Storing only odd numbers in the sieve
  - B. Using bit packing to store the boolean flags
  - C. Both A and B
  - D. None of the above
- Correct Answer: C. Both A and B

7. Which of the following is a drawback of the Simple Sieve algorithm?

- Options:
  - A. Requires less memory
  - B. Requires more memory
  - C. Takes less time to execute
  - D. Takes more time to execute
- Correct Answer: B. O(n<sup>2</sup>)

2. Which of the following is true about the incremental sieve?

- Options:
  - a) It only finds prime numbers.
  - b) It finds both prime and composite numbers.
  - c) It only finds composite numbers.
  - d) It does not find any numbers.
- Correct Answer: d) It can handle larger ranges of numbers

3. Which of the following is not a step in the Sieve of Eratosthenes algorithm?

- Options:
  - A. Create a boolean array of size n+1
  - B. The number is divisible by 2
  - C. Mark all multiples of 2 as composite
  - D. Find the greatest common divisor of each number
- Correct Answer: D. Find the greatest common divisor of each number

4. What is the condition used to mark a number as composite in Simple Sieve?

- Options:
  - A. The number is divisible by 2
  - B. The number is divisible by 3
  - C. The number is divisible by any prime less than its square root
  - D. The number is divisible by any prime less than itself
- Correct Answer: C. The number is divisible by any prime less than its square root

5. How many prime numbers less than or equal to 100 can be found using the Sieve of Eratosthenes algorithm?

- Options:
  - A. 24
  - B. 25
  - C. 26
  - D. 13
- Correct Answer: B. 25

10. How many prime numbers are there between 100 and 200?

- Options:
  - A. 72
  - B. 121

point(n)

- Options:
  - a) O(log n)
  - b) O(n)
  - c) O(n log n)
  - d) O(p<sup>n</sup>)
- Correct Answer: c) O(n log n)

5. What is the space complexity of the segmented sieve?

- Options:
  - a) O(n)
  - b) O(n log n)
  - c) O(n log<sup>2</sup> n)
  - d) O(sqrt(n))
- Correct Answer: d) O(sqrt(n))

6. Which of the following is a disadvantage of the incremental sieve?

- Options:
  - a) It requires a large amount of memory.
  - b) It is slower than the incremental sieve.
  - c) It only works for small ranges.
  - d) It can only find prime numbers.
- Correct Answer: a) It requires a large amount of memory

7. Which of the following is a disadvantage of the segmented sieve?

- Options:
  - a) It requires a large amount of memory.
  - b) It is slower than the segmented sieve.
  - c) It only works for small ranges.
  - d) It can only find prime numbers.
- Correct Answer: a) It requires a large amount of memory

C. 10  
D. 12

- Correct Answer: A. 23
- 1. What is the main advantage of the segmented sieve algorithm over the traditional sieve of Eratosthenes algorithm?

- Options:
  - a) It uses less memory.
  - b) It is faster for small ranges of numbers.
  - c) It is easier to implement.
  - d) It can handle larger ranges of numbers.
- Correct Answer: d) It can handle larger ranges of numbers

2. Which of the following is true about the incremental sieve?

- Options:
  - a) It only finds prime numbers.
  - b) It finds both prime and composite numbers.
  - c) It only finds composite numbers.
  - d) It does not find any numbers.
- Correct Answer: a) It only finds prime numbers

3. What is the output of the incremental sieve when n=20 is given as input?

- Options:
  - a) 2 3 5 7 11 13 17
  - b) 2 3 5 7 11 13 17 19 20
  - c) 2 3 5 7 11 13 17 19
  - d) 2 3 5 7 12 13 17 19
- Correct Answer: c) 2 3 5 7 11 13 17 19

4. What is the time complexity of the given code snippet?

- ```
python
Copy code
f():
    ans = 0
    for i = to:
        for j = i; i < n; j += i:
            ans += 1
```
- Options:
 - a) O(n)
 - b) O(n²)
 - c) O(n log n)
 - d) O(n log² n)
 - Correct Answer: b) O(n²)

- 3. What is the relationship between the values of $\phi(n)$ and $\phi(m)$ for coprime positive integers n and m?

- Options:
 - a) $\phi(n) = \phi(m) + \phi(nm)$
 - b) $\phi(nm) = \phi(n)\phi(m)$
 - c) $\phi(nm) = \phi(n) - \phi(m)$
 - d) None of the above
- Correct Answer: b) $\phi(nm) = \phi(n)\phi(m)$

4. What is the output of $\phi(324)$?

- Options:
 - A. 198
 - B. 90
 - C. 108
 - D. 120
- Correct Answer: B. 90

5. What is the value of $\phi(3)$?

- Options:
 - A. 0
 - B. 1
 - C. 2
 - D. 3
- Correct Answer: C. 2

6. What is the ϕ function of the number 8?

- Options:
 - A. 1
 - B. 1
 - C. 2
 - D. 4
- Correct Answer: D. 4

7. What is the value of $\phi(n)$ for $n = 12$ using Euler's phi function?

- Options:
 - A. 1
 - B. 1
 - C. 2
 - D. 1
- Options:
 - A. 1
 - B. 1
 - C. 2
 - D. 1

2. What is the relationship between the values of $\phi(n)$ and $\phi(p^k n)$ for prime p and positive integer k?

- Options:
 - A) $\phi(p^k n) = p^{k-1} \phi(n)$
 - B) $\phi(p^k n) = p^k \phi(n)$
 - C) $\phi(p^k n) = p^k - p^{k-1} \phi(n)$
 - D) $\phi(p^k n) = (p-1)p^{k-1} \phi(n)$
- Options:
 - A) 1
 - B) 1
 - C) 2
 - D) 1

8. What is the formula for calculating the nth prime number using the Incremental Sieve algorithm?

- Options:
 - a) $(n-1)^2 + 2$
 - b) $n - h + 1$
- Options:
 - A) $\phi(n) = p^{k-1} \phi(k)$
 - B) $\phi(n) = p^k \phi(k)$
 - C) $\phi(n) = p^k - p^{k-1}$
 - D) $\phi(n) = (p-1)p^{k-1} \phi(k)$

C

D

A

B

- Correct Answer: D) 124

8. What is the ϕ function of the number 12?

C

D

A

B

- Options:
 - A) 0
 - B) 1
 - C) 2
 - D) 4

Correct Answer: D) 101

3. Which of the following is not a Strobogrammatic Number?

C

D

A

B

- Options:
 - A) 111
 - B) 101
 - C) 1001
 - D) There is no strobogrammatic number that is prime.

Correct Answer: B) 101

4. Which of the following statements is true about Strobogrammatic Numbers?

C

D

A

B

- Options:
 - A) $\phi(n)$ is always even for any positive integer n .
 - B) $\phi(n)$ is equal to the number of divisors of n .
 - C) $\phi(p) = p-1$ for any prime number p .
 - D) $\phi(n)$ is always greater than n for any positive integer n .

Correct Answer: C) $\phi(p) = p-1$ for any prime number p .

5. What is the value of Euler's Totient Function for the number 2000?

C

D

A

B

- Options:
 - A) 1789
 - B) 1880
 - C) 1800
 - D) 1670

Correct Answer: B) 1800

6. Which of the following is a property of Euler's phi function?

C

D

A

B

- Options:
 - A) $\phi(n)$ is always even for any positive integer n .
 - B) $\phi(n)$ is equal to the number of divisors of n .
 - C) $\phi(p) = p-1$ for any prime number p .
 - D) $\phi(n)$ is always greater than n for any positive integer n .

Correct Answer: C) $\phi(p) = p-1$ for any prime number p .

7. Which of the following statements is true regarding the Chinese Remainder Theorem?

C

D

A

B

- Options:
 - A) It can only be applied to solve systems of congruences with prime moduli.
 - B) It can be applied to solve systems of congruences with composite moduli.
 - C) It can be applied to solve systems of congruences with any moduli.
 - D) It can only be applied to solve systems of congruences with integer moduli.

Correct Answer: B) It can be applied to solve systems of congruences with composite moduli

8. Consider a number that leaves a remainder of 2 when divided by 3, a remainder of 4 when divided by 5, and a remainder of 6 when divided by 7. What is the number according to the Chinese Remainder Theorem?

C

D

A

B

- Options:
 - A) 114
 - B) 119
 - C) 123
 - D) 134

Correct Answer: C) 123

9. What will be the output of the following code?

C

D

A

B

- Options:
 - A) 133
 - B) 122
 - C) 112
 - D) 134

Correct Answer: C) 112

10. In cryptography, the Chinese Remainder Theorem is used for:

C

D

A

B

- Options:
 - A) Generating random numbers.
 - B) Encrypting messages.
 - C) Decrpyting messages.
 - D) Hashing algorithms.

Correct Answer: B) Encrypting messages

1. What is the shape of an hourglass in a 2D array?

C

D

A

B

- Options:
 - A) Square
 - B) L-shape
 - C) T-shape
 - D) Hourglass.

Correct Answer: D) Hourglass

2. How many elements does a standard hourglass in a 2D array contain?

C

D

A

B

- Options:
 - A) 5
 - B) 6
 - C) 7
 - D) 8

Correct Answer: C) It has 7 distinct hourglasses can be found

3. In a 6x6 matrix, how many distinct hourglasses can be found?

C

D

A

B

- Options:
 - A) 176
 - B) 177
 - C) 178
 - D) 179

Correct Answer: B) 177

4. Consider a number that leaves a remainder of 2 when divided by 3, a remainder of 4 when divided by 5, and a remainder of 6 when divided by 7. What is the number according to the Chinese Remainder Theorem?

C

D

A

B

- Options:
 - A) 114
 - B) 119
 - C) 123
 - D) 134

Correct Answer: C) 123

- Options:
 A) 16
 B) 20
 C) 36
 D) 49
- Correct Answer: B) 24
4. Which of the following best describes the process of finding an hourglass sum in a matrix?
- Options:
 A) Calculate the sum of all elements in the matrix.
 B) Calculate the sum of elements in each possible hourglass shape.
 C) Calculate the sum of elements in each row.
 D) Calculate the sum of elements in each column.
- Correct Answer: B) Calculate the sum of elements in each possible hourglass shape.
5. What is the time complexity of finding the maximum hourglass sum in a 6x6 matrix?
- Options:
 A) O(1)
 B) O(n)
 C) O(n^2)
 D) O(n^3)
- Correct Answer: C) O(n^2)
6. Which of the following loops is essential in the implementation of finding an hourglass sum?
- Options:
 A) A single loop iterating over all elements.
 B) Two nested loops iterating over rows and columns.
 C) Three nested loops iterating over rows, columns, and diagonals.
 D) A loop iterating only over diagonals.
- Correct Answer: B) Two nested loops iterating over rows and columns.
7. What should be initialized before iterating through the matrix to find the maximum hourglass sum?
- Options:
 A) Minimum possible integer value
 B) Maximum possible integer value
 C) Zero
 D) Matrix size
- Correct Answer: B) Use a max-heap data structure.
7. Which of the following is the most efficient way to keep track of the maximum value in a dynamic array when inserting and deleting elements frequently?
- Options:
 A) Use a balanced binary search tree.
 B) Use a max-heap data structure.
 C) Use an arraylist with sorting after each insertion.
 D) Use a HashMap to track maximum values.
- Correct Answer: B) Use a max-heap data structure.
8. When using Collections.max() method, what is the time complexity if the collection is a list?
- Options:
 A) O(1)
 B) O(log n)
 C) O(N)
 D) O(N log N)
- Correct Answer: C) O(N)
9. In Java, which of the following classes implements the Navigable Map interface and supports operations for retrieving the maximum key?
- Options:
 A) HashMap
 B) TreeMap
 C) LinkedHashMap
 D) ConcurrentHashMap
- Correct Answer: B) TreeMap
10. Given the following code snippet, what is the expected output if the PriorityQueue is used for storing integers?
- ```
java
PriorityQueue<Integer> pq = new PriorityQueue<>(Collections.reverseOrder());
pq.add(10);
pq.add(20);
pq.add(30);
System.out.println(pq.peek());
```
- Options:  
 A) 2  
 B) 4  
 C) 6  
 D) 8
4. Consider the array A = {2, 4, 3, 6, 5, 8}. Which of the following elements is a leader?
- Options:  
 A) 2  
 B) 6  
 C) 1  
 D) 8
5. If an array contains negative numbers only, what is true about the leader of the array?
- Options:  
 A) The smallest negative number is always a leader.  
 B) The largest negative number is always a leader.  
 C) No negative number can be a leader.  
 D) All negative numbers are leaders.
- Correct Answer: B) The largest negative number is always a leader.
6. Which of the following operations can help in finding leaders efficiently in a large array?
- Options:  
 A) Precomputing the maximum values for suffixes  
 B) Sorting the array and then scanning  
 C) Using a hash map to store all elements  
 D) Computing all possible subarrays
- Correct Answer: A) Precomputing the maximum values for suffixes
7. Given an array A = [1, 2, 3, 4, 5, 6], which of the following statements is true about leaders in this array?
- Options:  
 A) All elements are leaders.  
 B) Only the last element is a leader.  
 C) The first element is a leader.  
 D) No elements are leaders.
- Correct Answer: B) Only the last element is a leader.
8. For an array A of length n, what is the space complexity of the optimal solution for finding all leaders?
- Options:  
 A) O(n)  
 B) O(log n)  
 C) O(1)  
 D) O(n^2)
- Correct Answer: A) O(n)
9. Which data structure can be utilized to efficiently keep track of the maximum elements seen so far while traversing an array from right to left?
- Options:  
 A) Stack

- **Correct Answer:** A) Stack
- **Options:**
  - A) Queue
  - C) Linked List
  - D) Binary Search Tree

10. In an array A where  $A = [15, 7, 3, 7, 6, 8]$ , which of the following pairs of elements could be leaders if we choose the array A to be a modified version where some elements are shifted?

- **Options:**
  - A) It appears at least  $n/4$  times.
  - B) It appears at least  $n/3$  times.
  - C) It appears at least  $n/2$  times.
  - D) It appears at least  $n$  times.
- **Correct Answer:** C) It appears at least  $n/2$  times.

4. Given the following Java code, what will be the output if the input array is  $[1, 2, 3, 2, 2, 1, 2, 2]?$

```
java
Copy code
public int majorityElement(int[] nums) {
 int count = 0, candidate = 0;
 for (int num : nums) {
 if (count == 0) {
 candidate = num;
 }
 count += (num == candidate) ? 1 : -1;
 }
 return candidate;
}
```

5. Which of the following conditions must be true for an element to be considered a majority element in an array of size n?

- **Options:**
  - A)  $O(n)$
  - B)  $O(\log n)$
  - C)  $O(n^2)$
  - D)  $O(n \log n)$
- **Correct Answer:** A)  $O(n)$

6. Consider the following array:  $[3, 3, 4, 2, 4, 2, 4]$ . Which element is the majority element according to the Boyer-Moore Voting Algorithm?

- **Options:**
  - A) 2
  - B) 3
  - C) 4
  - D) No majority element
- **Correct Answer:** C) 4

9. Which Java method can be used to verify if a candidate is indeed the majority element after using the Boyer-Moore Voting Algorithm?

• **Options:**

- A) Collections.frequency()
- B) Arrays.binarySearch()
- C) Stream.count()
- D) Arrays.sort()

• **Correct Answer:** A) Collections.frequency()

10. If an array contains multiple majority elements, which of the following statements is true for the Boyer-Moore Voting Algorithm?

- **Options:**
  - A) It will return the first majority element it encounters.
  - B) It will return a random majority element.
  - C) It will fail to find any majority element.
  - D) There can only be one majority element.
- **Correct Answer:** D) There can only be one majority element.

1. What is the lexicographically first palindromic string among the following?

• **Options:**

- A. madam
- B. civic
- C. alibophobia

Explanation: The string "racecar" is a palindrome, so the output will be "Palindrome".

- A) It appears at least  $n/4$  times.
- B) It appears at least  $n/3$  times.
- C) It appears at least  $n/2$  times.
- D) It appears at least  $n$  times.

6. In the Boyer-Moore Voting Algorithm, what happens when the count variable becomes zero?

- **Options:**
  - A) The candidate is confirmed as the majority element.
  - B) The candidate is discarded, and a new candidate is chosen.
  - C) The algorithm terminates.
  - D) The count is reset to 1.
- **Correct Answer:** B) The candidate is discarded, and a new candidate is chosen.

7. Given the following Java code, what will be the output if the input array is  $[2, 2, 1, 1, 2, 2]?$

```
java
Copy code
public int majorityElement(int[] nums) {
 int count = 0, candidate = 0;
 for (int num : nums) {
 if (count == 0) {
 candidate = num;
 }
 count += (num == candidate) ? 1 : -1;
 }
 return candidate;
}

• Options:

- A) 1
- B) 2
- C) 3
- D) 0

```

• **Correct Answer:** B) 2

4. Which of the following approaches can be used to check if a string is a palindrome?

- **Options:**
  - A. Two-pointer technique
  - B. Recursion
  - C. Using a stack
  - D. All of the above
- **Correct Answer:** D. All of the above
- **Explanation:** All listed techniques can be used to check if a string is a palindrome.

5. Given the string `str = "aababc"`, what will be the lexicographically first palindromic string that can be formed?

- **Options:**
  - A. abcba
  - B. ababa
  - C. acbca
  - D. No palindrome can be formed
- **Correct Answer:** A. abcba
- **Explanation:** All valid palindrome can be formed by sorting the characters and forming the lexicographically first palindrome.

6. Which of the following is the correct approach to find the lexicographically first palindromic string in Java?

- **Options:**
  - A. Sort the string, then form a palindrome.
  - B. Find all permutations of the string and check each for palindromes.
  - C. Use a frequency array to count characters, then form the palindrome.
  - D. Use dynamic programming to find the longest palindromic subsequence.
- **Correct Answer:** A. Sort the string, then form a palindrome.
- **Explanation:** Sorting the string allows the formation of the lexicographically first palindrome.

7. What does the following Java code snippet print?

```
java
Copy code
```

**Copy code**

```
String str = "abb";
char[] chars = str.toCharArray();
Arrays.sort(chars);
String sortedStr = new String(chars);
System.out.println(sortedStr);
```

**Options:**

- Options:
  - A. Stack
  - B. Queue
  - C. HashMap
  - D. LinkedList

**Correct Answer:** C. HashMap is ideal for storing character/frequencies because it allows quick lookup and update of character counts.

*Explanation: A HashMap is ideal for storing character/frequencies because it allows quick lookup and update of character counts.*

**1. Which of the following classes in Java implements the Comparable interface to define natural ordering?**

**Options:**

- Options:
  - A. HashMap
  - B. ArrayList
  - C. String
  - D. LinkedList

**Correct Answer:** B. All characters except one must occur an even number of times.

*Explanation: To define the natural order of a class, it must implement the compareTo() method from the Comparable interface.*

**2. What method must a class implement to define its natural order?**

**Options:**

- Options:
  - A. compareTo()
  - B. compare()
  - C. sort()
  - D. order()

**Correct Answer:** A. compareTo()

*Explanation: To define the natural order of a class, it must implement the compareTo() method from the Comparable interface.*

**3. What will be the output of the following code?**

```
java
```

**8. What happens if a class that implements Comparable does not provide a consistent compareTo method?**

**Options:**

- Options:
  - A. The class will fail to compile.
  - B. Sorting operations may produce incorrect results or throw exceptions.
  - C. The compareTo method will be ignored.
  - D. The equals method will override compareTo.

**Correct Answer:** B. Sorting operations may produce incorrect results or throw exceptions.

*Explanation: If compareTo() is inconsistent (e.g., it doesn't properly order objects), sorting operations might yield incorrect results or even throw exceptions.*

**9. What is the purpose of the reverse() method in the StringBuilder class?**

**Options:**

- Options:
  - A. To reverse the characters in a string
  - B. To compare two strings
  - C. To find the lexicographically smallest string
  - D. To split a string into substrings

**Correct Answer:** A. To reverse the characters in a string

*Explanation: The reverse() method reverses the characters in a StringBuilder object.*

**6. Given the following class definition, what is true about the compareTo method?**

```
java
Copy code
public class Person implements Comparable<Person> {
 private String name;
}
```

**Options:**

- Options:
  - A. It compares Person objects based on their names.
  - B. It will cause a compilation error.
  - C. It compares Person objects based on their hash codes.
  - D. It is a valid implementation of Comparable.

**Correct Answer:** A. It compares Person objects based on their names.

*Explanation: The compareTo() method compares Person objects based on their name property.*

**7. Which of the following statements is true about the natural order of a class that implements Comparable?**

**Options:**

- Options:
  - A. The natural order must be consistent with equals().
  - B. The natural order must be defined in a separate comparator class.
  - C. The natural order cannot be overridden.
  - D. The natural order is determined at runtime.

**Correct Answer:** A. The natural order must be consistent with equals().

*Explanation: The natural order of a class that implements Comparable should be consistent with equals(), meaning if two objects are considered equal according to compareTo(), equals() should return true.*

**8. How does the compareTo method in the Comparable interface signal that one object is greater than, equal to, or less than another?**

**Options:**

- Options:
  - A. By returning a boolean value
  - B. By throwing an exception
  - C. By returning an integer
  - D. By calling another method

**Correct Answer:** C. By returning an integer

*Explanation: The compareTo() method returns an integer, a negative value if the object is less than the other, zero if they are equal, and a positive value if the object is greater.*

**5. Which class in Java uses the natural ordering of its elements?**

**Options:**

- Options:
  - A. HashSet
  - B. TreeSet
  - C. LinkedHashMap
  - D. Vector

**Correct Answer:** B. TreeSet uses the natural ordering of its elements, or an ordering defined by a Comparator.

**6. Given the following code, what will happen if the Product class does not provide a consistent compareTo method?**

```
@Override
public int compareTo(Product other) {
 return Double.compare(this.price, other.price);
}
```

**Options:**

- Options:
  - A. Products will be sorted alphabetically by name.
  - B. Products will be sorted by price in ascending order.
  - C. Products will be sorted by price in descending order.
  - D. Sorting will throw a NoSuchElementException.

**Correct Answer:** B. Products will be sorted by price in ascending order.

*Explanation: The compareTo() method compares Product objects by their price, so sorting will order them by price in ascending order.*

**1. Which of the following classes in Java implements the Comparable interface to define its natural ordering?**

**Options:**

- Options:
  - A. HashTable
  - B. ArrayList
  - C. String
  - D. LinkedList

**Correct Answer:** C. String

*Explanation: The String class implements the Comparable interface to define its natural ordering based on lexicographical order.*

**2. What method must a class implement to define its natural order?**

**Options:**

- Options:
  - A. compareTo()
  - B. compare()
  - C. sort()
  - D. order()

**Correct Answer:** A. compareTo()

*Explanation: To define the natural order of a class, it must implement the compareTo() method from the Comparable interface.*

**3. What will be the output of the following code?**

```
java
Copy code
class Product implements Comparable<Product> {
 String name;
 double price;
}
```

**Product(String name, double price) {**

```
 this.name = name;
 this.price = price;
}
```

- java  
Copy code
- ```
public class Person implements Comparable<Person> {
    private String name;
    public int compareTo(Person other) {
        return this.name.compareTo(other.name);
    }
}
```
- @Override
Collections.sort(list);
System.out.println(list);
- A. [1, 2, 3]
 - B. [3, 2, 1]
 - C. [2, 3, 2]
 - D. [1, 3, 2]
- Correct Answer: A. [1, 2, 3]**
Explanation: The `Collections.sort()` method sorts the list in ascending order, so the output will be [1, 2, 3].
4. How does the `compareTo` method in the `Comparable` interface signal that one object is greater than, equal to, or less than another?
- A. By returning a boolean value
 - B. By throwing an exception
 - C. By returning an integer
 - D. By calling another method
- Correct Answer: C. By returning an integer**
Explanation: The `compareTo()` method returns an integer: a negative value if the object is less than the other, zero if they are equal, and a positive value if the object is greater.
5. Which class in Java uses the natural ordering of its elements?
- A. HashSet
 - B. TreeSet
 - C. LinkedList
 - D. Vector
- Correct Answer: B. TreeSet**
Explanation: The `TreeSet` class uses the natural ordering of its elements, or an ordering defined by a Comparator.
6. Given the following class definition, what is true about the `compareTo` method?
- ```
java
```
- B. Products will be sorted by price in ascending order.
  - C. Products will be sorted by price in descending order.
  - D. Sorting will throw a `ClassCastException`.
- Correct Answer: B. Products will be sorted by price in ascending order.**  
*Explanation:* The `compareTo()` method compares Product objects by their price, so sorting will order them by price in ascending order.
1. A) A substring that appears multiple times in the string.  
○ B) A substring that has a weight assigned based on a specific criterion.  
○ C) A substring that is longer than a certain length.  
○ D) A substring that contains only vowels.
- Correct Answer: A) A substring that has a weight assigned based on a specific criterion.**
2. Given a string "abc" with weights {a: 1, b: 2, c: 3}, what is the weight of the substring "ab"?
- A) 1
  - B) 2
  - C) 3
  - D) 4
- Correct Answer: D) 4**  
*Explanation:* The weight of the substring "ab" is the sum of the weights of 'a' (1) and 'b' (2), giving a total of 3.
3. In the string "abcd", if each character has a weight equal to its position (1-based index), what is the weight of the substring "cd"?
- A) 3
  - B) 4
  - C) 7
  - D) 5
- Correct Answer: C) 7**  
*Explanation:* The weight of the substring "cd" is the sum of the weights of 'c' (3) and 'd' (4), giving a total of 7.
4. Which algorithm can be used to efficiently find the maximum weighted substring in a string?
- A) Brute force
- D. The `equals` method will override `compareTo`.  
Correct Answer: B) Sorting operations may produce incorrect results or throw exceptions.  
*Explanation:* If `compareTo()` is inconsistent (e.g., it doesn't properly order objects), sorting operations might yield incorrect results or even throw exceptions.
9. What is the primary reason to implement Comparable in a class?
- A. To allow objects of the class to be printed.
  - B. To define a natural ordering for objects of the class.
  - C. To enable deep cloning of objects of the class.
  - D. To enforce encapsulation of class fields.
- Correct Answer: B. To define a natural ordering for objects of the class.**  
*Explanation:* The main purpose of implementing Comparable is to define the natural ordering of objects, allowing them to be compared and sorted.
10. Given the following class definition, what would be the result of sorting a list of `Product` objects?
- ```
java  
Copy code
```
- ```
class Product implements Comparable<Product> {
 String name;
 double price;
 public int compareTo(Product other) {
 String name;
 double price;
 return Double.compare(this.price, other.price);
 }
}
```
- A. Products will be sorted alphabetically by name.
8. What is the time complexity of calculating the weight of all substrings using a brute force approach?
- A)  $O(n)$
  - B)  $O(n^2)$
  - C)  $O(n^3)$
  - D)  $O(n^4)$
- Correct Answer: B)  $O(n^2)$**   
*Explanation:* To find the weight of all substrings, we generate all pairs of start and end indices of substrings, which results in  $O(n^2)$  complexity.
9. For the string "pat" with weights {p: 7, q: 5, t: 5}, what is the total weight of all possible substrings?
- A) 33
  - B) 42
  - C) 36
  - D) 144
- Correct Answer: B) 42**  
*Explanation:* The total weight is the sum of weights for all substrings: "`n`" (7), "`n`" (6), "`p`" (5), "`pq`" (13), "`qr`" (18). The total is  $7 + 6 + 5 + 13 + 11 + 18 = 42$ .
10. Which data structure can help in efficiently finding the maximum weighted substring in a large string?
- A) Array
  - B) Linked list
  - C) Segment tree
  - D) Queue
- Correct Answer: C) Segment Tree**  
*Explanation:* A segment tree is an efficient data structure that helps in answering range queries and can be used to efficiently find the maximum weighted substring in large strings.
1. Which pivot selection strategy can help in avoiding the worst-case scenario in Quick Sort?
- A) Always pick the first element as pivot
  - B) Always pick the last element as pivot
  - C) Pick a random element as pivot
  - D) Always pick the middle element as pivot
- Correct Answer: C) Segment Tree**  
*Explanation:* A segment tree is an efficient data structure that helps in answering range queries and can be used to efficiently find the maximum weighted substring in large strings.

**Explanation:** Picking a random element as pivot helps avoid the worst-case scenario ( $O(n^2)$ ) in case of already sorted or reverse-sorted arrays.

## 2. In Quick Sort, the process of dividing the array into two parts is called:

- A) Merging
  - B) Dividing
  - C) Partitioning
  - D) Conquering
- Correct Answer: C) Partitioning**
- Explanation:** Partitioning is the process of dividing the array into two parts based on the pivot element, where elements smaller than the pivot go to one side and elements greater go to the other.

## 3. Which of the following methods is used in Quick Sort to choose a pivot element?

- A) Median of three
  - B) First element
  - C) Random element
  - D) All of the above
- Correct Answer: D) All of the above**
- Explanation:** Quick Sort can use various methods like median of three, first element, or a random element for selecting the pivot.

## 4. What is the primary advantage of using Quick Sort over other sorting algorithms?

- A) Simplicity of implementation
  - B) Stability
  - C) In-place sorting
  - D) Requires less memory
- Correct Answer: C) In-place sorting**
- Explanation:** Quick Sort is a in-place sorting algorithm, meaning it doesn't require extra space for storing elements.
- 5. In Quick Sort, if the input array is already sorted in ascending order, which pivot selection strategy is most likely to cause the worst-case scenario?**
- A) First element
  - B) Last element

- C) Middle element
  - D) Random element
- Correct Answer: A) First element**
- Explanation:** If the first element is selected as the pivot in a sorted array, it leads to the worst-case scenario ( $O(n^2)$ ) because the array is already partitioned in a skewed way.

## 6. Which of the following statements is true about the partitioning process in Quick Sort?

- A) The pivot elements are always placed at the start of the array.
  - B) The pivot elements are always placed at the end of the array.
  - C) The pivot elements are always placed in its correct sorted position.
  - D) The pivot elements are placed in the middle of the array.
- Correct Answer: C) The pivot element is always placed in its correct sorted position.**
- Explanation:** After the partitioning process, the pivot element is placed in its correct position, and the elements on the left are smaller, while those on the right are larger.
- 7. What is a common strategy to handle the case when the input array has many duplicate elements in Quick Sort?**
- A) Use a stable version of Quick Sort
  - B) Use three-way partitioning
  - C) Use the first element as pivot
  - D) Switch to Selection Sort

## 8. What is a key difference between Quick Sort and Merge Sort?

- A) Quick Sort is stable, Merge Sort is not
  - B) Quick Sort is in-place, Merge Sort is not
  - C) Quick Sort always uses the first element as pivot, Merge Sort uses the middle element
  - D) Quick Sort divides the array into two equal halves, Merge Sort does not
- Correct Answer: B) Quick Sort is in-place, Merge Sort is not**
- Explanation:** Three-way partitioning is used to handle duplicates efficiently by splitting the array into three parts, less than, equal to, and greater than the pivot.

## 9. In which of the following scenarios is Quick Sort preferred over Merge Sort?

- A) When a stable sort is required
- B) When the input array is large and partially sorted
- C) When in-place sorting is required
- D) When the input array is small and random

**Correct Answer: C) When in-place sorting is required**

**Explanation:** Quick Sort is preferred when in-place sorting is required because it doesn't need extra memory like Merge Sort.

## 10. Which of the following is a correct way to implement the partition function in Quick Sort?

- A) Hoare partition scheme
  - B) Lomuto partition scheme
  - C) Median-of-three partition scheme
  - D) All of the above
- Correct Answer: D) All of the above**
- Explanation:** There are different partition schemes in Quick Sort, including Hoare and Lomuto, and the median-of-three method for pivot selection.
- 1. Which of the following is the correct way to move all hyphens to the beginning of a string in Java?**
- A) String result = str.replaceAll("-", "");
  - B) String result = str.replaceAll("-", "") + str.replaceAll("-", "-");
  - C) String result = str.replaceAll("-", "") + str.replaceAll("-", "-");
  - D) String result = str.replaceAll("-", "") + str.replaceAll("-", "-") + str.replaceAll("-", "-");
- 2. Given a string str = "a-b-c-d", what will be the result of the following code?**
- java

```
Copy code
String str = "a-b-c-d";
for (int i = 0; i < str.length(); i++) {
 str.insert(i, '-');
}
```

java

```
Copy code
String str = "a-b-c-d";
if (ch == '-') {
 count++;
} else {
 str.append(ch);
}
```

System.out.println(str.toString());
- A) abcd---
  - B) ----abcd
  - C) a-b-cd
  - D) abcd-
- Correct Answer: B) ----abcd**
- Explanation:** The regex `[-]` matches all characters that are not hyphens, so the result is `----abcd`.
- 3. Which of the following regular patterns correctly matches all non-hyphen characters in a string?**
- A) [-]
  - B) [-]
  - C) [a-zA-Z][^ -]
  - D) [a-zA-Z][^ -]
- Correct Answer: C) [a-zA-Z][^ -]**
- Explanation:** The regex `[^ -]` matches all characters that are not hyphens.

## 6. Which of the following regular patterns correctly matches all non-hyphen characters in a string?

- A) abc-
- B) ---abcd-
- C) a-b-c-d
- D) abc-----

**Correct Answer: B) ---abcd-**

**Explanation:** The `str.replaceAll(" ", "")` removes all hyphens, producing "abc" and `str.replaceAll("(-)", "-")` removes all non-hyphen characters, leaving "...". The result is "....abcd".

## 7. Given a string str = "a-b-c-d", what will be the result of the following code?

- java
- ```
Copy code
String str = "a-b-c-d";
for (char ch : str.toCharArray()) {
    if (ch == '-') {
        str.insert(0, ch);
    }
}
```
- java
- ```
Copy code
StringBuilder sb = new StringBuilder();
for (char ch : str.toCharArray()) {
 if (ch == '-') {
 str.insert(0, ch);
 }
}
```
- Correct Answer: B) ----abcd**
- Explanation:** The `StringBuffer` class has a `insert()` method that can be used to efficiently build the string by appending creation.
- 4. Which of the following methods can be used to move all hyphens to the beginning of a string without using `replaceAll()`?**
- A) Stringbuilder
  - B) StringBuffer
  - C) String
  - D) Array
- Correct Answer: A) Stringbuilder**
- Explanation:** The `StringBuilder` method involves regular expression evaluation and string creation, which results in a time complexity of  $O(n^2)$  due to the intermediate string creation.
- 5. Given the string str = "a-b-c-d", which of the following snippets correctly moves all hyphens to the beginning?**
- java

```
Copy code
StringBuilder sb = new StringBuilder();
for (char ch : str.toCharArray()) {
 if (ch == '-') {
 str.insert(0, ch);
 }
}
```

**Explanation:** This code counts the hyphens, removes them, and then inserts the same number of hyphens at the beginning.

**10. What does the `replaceAll("-", "")` part of the code do?**

- **A)** Replaces all hyphens with empty strings.
- **B)** Removes all non-hyphen characters from the string.
- **C)** Removes all non-hyphen characters from the string.
- **D)** Replaces all non-hyphen characters with empty strings.

**Correct Answer:** D) Replaces all non-hyphen characters with empty strings.  
**Explanation:** The `replaceAll("-", "")` removes all characters that are not hyphens.

**1. What problem does Manacher's algorithm solve efficiently?**

- A) Longest common subsequence
- B) Longest palindromic substring
- C) Shortest path in a graph
- D) Sorting an array

**Answer:** B) Longest palindromic substring

**2. Which data structure is primarily used in Manacher's algorithm?**

- A) Stack
- B) Queue
- C) Hash table
- D) None of the above

**Answer:** D) None of the above

**3. What is the time complexity of Manacher's algorithm?**

- A)  $O(n)$
- B)  $O(n \log n)$
- C)  $O(n^2)$
- D)  $O(n^3)$

**Answer:** A)  $O(n)$

**7. What is the space complexity of Manacher's algorithm?**

- A) Dynamic programming
- B) Two-pointer technique
- C) Extension by one character
- D) None of the above

**Answer:** C) Extension by one character

**8. Which of the following is NOT a characteristic of Manacher's algorithm?**

- A) Efficiently finds all palindromic substrings
- B) Requires  $O(n)$  time complexity
- C) Utilizes dynamic programming
- D) Does not require any additional data structures

**Answer:** C) Utilizes dynamic programming

**4. Which of the following is a preprocessing step in Manacher's algorithm?**

- A) Sorting the characters

**5. In which order are sorted unique permutations typically generated using backtracking?**

- A) Random order
- B) Reverse lexicographical order
- C) lexicographical order
- D)  $O(n!)$

**Answer:** C) lexicographical order

**8. Which approach is typically used to avoid generating duplicate permutations in algorithms that generate all permutations?**

- A) Hashing
- B) Scoring
- C) Backtracking
- D) Dynamic programming

**Answer:** C) Backtracking

**3. What is the time complexity for generating all sorted unique permutations of a string of length  $n$  using backtracking?**

- A)  $O(n)$
- B)  $O(n \log n)$
- C)  $O(n!)$
- D)  $O(2^n)$

**Answer:** C)  $O(n!)$

**4. What is the time complexity for generating all sorted unique permutations of a string of length  $n$  using backtracking?**

- A)  $O(n)$
- B)  $O(n \log n)$
- C)  $O(n!)$
- D)  $O(2^n)$

**Answer:** C)  $O(n!)$

**5. Which data structure is suitable for efficiently checking and maintaining used characters during permutation generation?**

- A) Stack
- B) Queue
- C) Set
- D) Array

**Answer:** C) Set

**6. Which key property of sorted unique permutations distinguishes them from all possible permutations?**

- A) They are sorted in descending order
- B) They are sorted in ascending order
- C) They contain all characters of the original string
- D) They have the maximum length possible

**Answer:** B) They are sorted in ascending order

**7. What is the main advantage of Manacher's algorithm over a naive approach to find palindromic substrings?**

- A) It guarantees finding the longest palindromic substring
- B) It has a lower time complexity
- C) It uses less memory
- D) It can handle only odd-length palindromes efficiently

**Answer:** B) It has a lower time complexity

**10. In which year was Manacher's algorithm proposed?**

- A) 1975
- B) 1989
- C) 1995
- D) 2005

**Answer:** B) 1989

**1. What is a sorted unique permutation of a string?**

- A) A permutation where characters are sorted in descending order
- B) A permutation where characters are sorted in ascending order and no characters are repeated
- C) A permutation where characters are in any order and can repeat
- D) None of the above

**Answer:** B) A permutation where characters are sorted in ascending order and no characters are repeated

**2. How many sorted unique permutations can be generated from the string "ABC"?**

- A) 3
- B) 6
- C) 9
- D) 12

**Answer:** B) 6

**3. Which algorithmic technique is commonly used to generate sorted unique permutations efficiently?**

- A) Depth-first search (DFS)
- B) Breadth-first search (BFS)

**Answer:** A) Depth-first search (DFS)

**4. Which term is used to describe a sudden change in direction or tactic to gain an advantage in a competitive situation?**

- A) Pivot
- B) Retreat
- C) Maneuver
- D) Stagnation

**Answer:** C) Maneuver

**5. What is the primary goal of offensive maneuvering in military strategy?**

- A) Protecting supply lines
- B) Holding defensive positions
- C) Gaining a tactical advantage
- D) Avoiding engagements

**Answer:** C) Gaining a tactical advantage

**6. Which driving maneuver involves reversing the vehicle to change its direction?**

- A) U-turn
- B) Parallel parking
- C) Three-point turn
- D) J-turn

**Answer:** D) J-turn

**2. Which of the following is a key principle of defensive maneuvering in driving?**

- A) Tageting
- B) Anticipating hazards

**Answer:** B) Anticipating hazards

7. In naval warfare, what does "maneuvering" typically refer to?

- A) Firing cannons
  - B) Sailing tactics
  - C) Anchoring ships
  - D) Repairing hulls
- Answer: B) Sailing tactics**
8. Which factor is crucial for effective maneuvering in team sports such as basketball or soccer?
- A) Individual scoring ability
  - B) Team communication
  - C) Timekeeping
  - D) Spectator support
- Answer: B) Team communication**
9. What is a primary consideration for safe maneuvering in mountain climbing?
- A) Climbing in a straight line
  - B) Speeding up to reach the summit faster
  - C) Using proper safety equipment
  - D) Climbing alone
- Answer: C) Using proper safety equipment**
10. Which of the following statements about maneuvering is true across various contexts?
- A) It always involves aggressive actions
  - B) It can only be strategic, not tactical
  - C) Requires adaptability and quick decision-making
  - D) It is a slow and deliberate process
- Answer: C) Requires adaptability and quick decision-making**

1. In how many ways can you choose 3 books from a shelf containing 7 different books?

- A) 21
  - B) 35
  - C) 42
- Answer: B) 35**
2. A committee of 5 people is to be formed from a group of 10 individuals. How many different committees can be formed?
- A) 252
  - B) 210
  - C) 120
  - D) 90
- Answer: B) 210**
- (This is a combination problem:  $\binom{10}{5} = \frac{10!}{(10-5)!5!} = \frac{10 \times 9 \times 8 \times 7 \times 6}{5 \times 4 \times 3 \times 2 \times 1} = 210$ )
3. How many different 4-letter combinations can be formed from the letters A, B, C, D, E, F without repetition?
- A) 120
  - B) 360
  - C) 720
  - D) 24
- Answer: C) 720**
- (This is a permutation problem:  $P(6,4) = 6 \times 5 \times 4 \times 3 = 360$ )
4. How many ways can you arrange the letters in the word "COMBINATIONS"?
- A) 5040
  - B) 563800
  - C) 40320
  - D) 1440
- Answer: B) 362880**
- (There are 11 letters with repeated "O", "I", "N", "T", which result in this calculation:  $11! / (2!2!2!)(\text{fac}(1!))^2(2!2!1!)$ )
5. In a lottery, 5 numbers are to be picked from 1 to 50. How many different combinations of numbers can be chosen?

- A) 218760
  - B) 1024
  - C) 3125
  - D) 2589560
- Answer: D) 2589560**
- (This is a combination problem:  $\binom{50}{5} = \frac{50!}{(50-5)!5!} = \frac{50 \times 49 \times 48 \times 47 \times 46}{5 \times 4 \times 3 \times 2 \times 1} = 218760$ )
6. How many ways can you select 2 red marbles and 3 blue marbles from a collection of 10 red and 15 blue marbles?
- A) 240
  - B) 3003
  - C) 252
  - D) 126
- Answer: C) 252**
- (This is a combination problem:  $\binom{10}{2} \times \binom{15}{3} = \frac{10!}{(10-2)!2!} \times \frac{15!}{(15-3)!3!} = 45 \times 455 = 252$ )
7. A password consists of 4 digits where the first digit cannot be 0. How many different passwords are possible?
- A) 9000
  - B) 7290
  - C) 6480
  - D) 1651
- Answer: A) 9000**
- (For the first digit, there are 9 options (1-9) and for each of the next three digits, there are 10 options (0-9);  $9 \times 10 \times 10 \times 10 = 9000$ )
8. How many different 7-digit telephone numbers can be formed if each number must start with 5 and no digit can be repeated?
- A) 720
  - B) 5040
  - C) 362880
- Answer: B) 5040**
- (This is a permutation problem:  $P(6,6) = 6! = 720$ )
9. In the Josephus problem, what position would the last remaining person be?
- A) 9
  - B) 12
  - C) 16
  - D) 19
- Answer: C) 16**
- (The Josephus problem for 10 people with every second person eliminated, position 5 is the safe one.)
10. In a circle of 20 people playing the Josephus game (every 3rd person is eliminated), what position would the last remaining person be?
- A) 13
  - B) 17
  - C) 19
  - D) 23
- Answer: B) 17**
- (For 20 people, eliminating every 5th person, position 17 is the last remaining person.)
3. The Josephus problem is a classic theoretical problem:
- A) Graph theory
  - B) Number theory
  - C) Game theory
  - D) Combinatorics
- Answer: C) Game theory**
- (The Josephus problem is a problem in game theory that involves elimination and strategy in a circular setup.)
4. If there are 15 people standing in a circle and every 4th person is eliminated until only one remains, which position is safe from elimination?
- A) 9
  - B) 11
  - C) 12
  - D) 15
- Answer: B) 11**
- (For 15 people, eliminating every 4th person, position 11 is the safe one.)
5. In the Josephus problem with 10 people where every 2nd person is eliminated, what is the safe position?
- A) 4
  - B) 5
  - C) 7
  - D) 10
- Answer: B) 5**
- (With 8 people and eliminating every 3rd person, position 7 is the last remaining.)
9. The Josephus problem finds applications in:
- A) Cryptography
  - B) Sorting algorithms
  - C) Data compression

- o D) None of the above  
**Answer: D) None of the above**  
 (The 8-queens problem is a theoretical problem used to demonstrate elimination patterns and does not have direct applications in cryptography, sorting, or data compression.)
10. If there are 30 people standing in a circle and every 6th person is eliminated, which position will be the last person standing?  
 o A) 12  
 o B) 16  
 o C) 18  
 o D) 30  
**Answer: B) 16**  
 (For n = 30 people and eliminating every 6th person, position 16 will be the last remaining person.)
1. What is a common algorithm used for solving mazes with a single solution path?  
 o A) Depth-First Search (DFS)  
 o B) Breadth-First Search (BFS)  
 o C) Dijkstra's Algorithm  
 o D) A\* Search Algorithm  
**Answer: A) Depth-First Search (DFS)**  
 (DFS is commonly used for maze-solving when there is a single solution path, as it explores each path deeply before backtracking.)
2. Which data structure is typically used to implement DFS and BFS for maze solving?  
 o A) Queue  
 o B) Stack  
 o C) Priority Queue  
 o D) Limited List  
**Answer: B) Stack (for DFS)**  
 (DFS uses a queue, while BFS uses a stack to manage the exploration of nodes in the maze.)
3. Which algorithm guarantees finding the shortest path in an unweighted maze?  
 o A) Depth-First Search (DFS)
4. Which heuristic is commonly used in the A\* search algorithm for maze solving?  
 o A) Manhattan distance  
 o B) Euclidean distance  
 o C) Hamming distance  
 o D) Chebyshev distance  
**Answer: A) Manhattan distance**  
 (Manhattan distance is commonly used in grid-based mazes, where movements are restricted to horizontal and vertical directions.)
5. In maze solving, what does the term "backtracking" refer to?  
 o A) A method to find dead-ends  
 o B) Reversing the path taken  
 o C) A systematic way to explore paths  
 o D) Eliminating invalid paths  
**Answer: B) Reversing the path taken**  
 (Backtracking refers to retracing steps to explore alternative paths after reaching a dead-end.)
6. Which traversal technique is more suitable for finding all possible solutions in a maze?  
 o A) Depth-First Search (DFS)  
 o B) Breadth-First Search (BFS)  
 o C) Dijkstra's Algorithm  
 o D) A\* Search Algorithm  
**Answer: B) Stack (for DFS)**  
 (DFS explores as deeply as possible into the maze, thus allowing it to find all possible solutions.)
7. Which algorithm is preferred for finding the shortest path in a weighted maze?  
 o A) Depth-First Search (DFS)
8. What is the time complexity of Breadth-First Search (BFS) for maze solving?  
 o A)  $O(V)$   
 o B)  $O(E)$   
 o C)  $O(V+E)$   
 o D)  $O(V^2)$   
**Answer: C)  $O(V+E)$**   
 ( $O(V+E)$  is the time complexity of BFS if  $V$  is the number of vertices and  $E$  is the number of edges.)
9. Which of the following algorithms is not suitable for maze solving that involves finding the shortest path?  
 o A) Breadth-First Search (BFS)  
 o B) Depth-First Search (DFS)  
 o C) Dijkstra's Algorithm  
 o D) A\* Search Algorithm  
**Answer: B) Depth-First Search (DFS)**  
 (DFS does not guarantee the shortest path, as it explores one path fully before backtracking, which may lead to suboptimal solutions.)
10. Which algorithm is generally more efficient when a heuristic can be defined for the maze-solving problem?  
 o A) Depth-First Search (DFS)  
 o B) Breadth-First Search (BFS)  
 o C) Dijkstra's Algorithm  
 o D) A\* Search Algorithm  
**Answer: D) A\* Search Algorithm\***  
 (\*A\* search algorithm is designed to be efficient when a heuristic can be used to estimate the cost of reaching the goal.)
- Of the following given options, which one of the following is a correct option that provides an optimal solution for the 4-queens problem?  
 • A) (3,1,4,2)  
 • B) (2,3,1,4)  
 • C) (4,3,2,1)  
 • D) (4,2,3,1)  
**Answer: A) (3,1,4,2)**  
 (A 4-queens solution is a permutation of the numbers 1 through 4 in the four columns of an 8x8 chessboard such that no two queens share the same row, column, or diagonal.)
- How many possible solutions exist for an 8-queen problem?  
 • A) 100  
 • B) 98  
 • C) 92  
 • D) 88  
**Answer: C) 92**  
 (There are 92 distinct solutions to the 8-queens problem.)
- How many possible solutions occur for a 10-queen problem?  
 • A) 850  
 • B) 742  
 • C) 842  
 • D) 734  
**Answer: D) 734**  
 (For n = 10, there are 734 distinct solutions to the 10-queens problem.)
- If n=1, an imaginary solution for the problem exists.  
 • A) True  
 • B) False  
**Answer: B) False**  
 (For n = 1, there is no solution.)
- In how many directions do queens attack each other?  
 • A) 1  
 • B) 2  
 • C) 3  
 • D) 4  
**Answer: D) 4**  
 (Placing n-queens so that no two queens attack each other is called the n-queens problem.)
- Where is the n-queens problem implemented?  
 • A) Carrom  
 • B) Chess  
 • C) Ludo  
 • D) Cards  
**Answer: B) Chess**  
 (The n-queens problem is a well-known problem in computer science and mathematics, often solved using backtracking algorithms.)
- In n-queen problem, how many values of n does not provide an optimal solution?  
 • A) 1  
 • B) 2  
 • C) 3  
 • D) 4  
**Answer: B) 2**  
 (For n = 2 and n = 3, there is no solution.)
- Which of the following methods can be used to solve n-queen's problem?  
 • A) Greedy algorithm  
 • B) Divide and conquer  
 • C) Iterative improvement  
 • D) Backtracking  
**Answer: D) Backtracking**  
 (Backtracking is a common method used to solve the n-queens problem by iteratively placing queens in different positions and backtracking when a queen is placed in a position that attacks another queen.)
- In the implementation of Warnsdorff's algorithm, what is the "tie-breaking" strategy typically used when multiple moves have the same degree?  
 • A) Choosing the move that leads to the highest degree in the subsequent move
- What is the domination number for 8-queen's problem?  
 • A) 8  
 • B) 7  
 • C) 6  
 • D) 5  
**Answer: A) 8**  
 (The domination number for 8-queens is 8, as each queen controls 8 squares in its row, column, and diagonals.)
- What is the difference between an "open" and a "closed" knight's tour in the context of Warnsdorff's algorithm?  
 • A) An open tour starts and ends on different squares, while a closed tour starts and ends on the same square  
 • B) An open tour uses all squares of the board, while a closed tour does not  
 • C) An open tour allows visiting squares, while a closed tour does not  
 • D) An open tour's algorithm is based on Dijkstra's algorithm, while a closed tour's algorithm is based on Warnsdorff's algorithm  
**Answer: A) An open tour starts and ends on different squares, while a closed tour starts and ends on the same square**  
 (An open knight's tour is a sequence of moves that visits every square on a chessboard at least once, while a closed knight's tour is a sequence of moves that starts and ends on the same square.)
- In what way does Warnsdorff's algorithm utilize a greedy approach?  
 • A) It optimizes the total path length of the knight's tour  
 • B) It prioritizes moves that minimize the risk of getting trapped early  
 • C) It prioritizes moves that maximize the number of moves made by the knight  
 • D) It prioritizes moves that minimize the risk of getting trapped early  
**Answer: B) It prioritizes moves that minimize the risk of getting trapped early**  
 (Warnsdorff's algorithm is a greedy algorithm that always moves the knight to the square with the fewest possible moves available, which often leads to an optimal solution.)

**Q** How can Warnsdorff's algorithm be modified to increase the likelihood of finding a solution on larger boards?

- A) Implementing backtracking when a trap is detected
- B) Ignoring the least-constraining value heuristic
- C) Always starting the tour from the center of the board
- D) Implementing backtracking when a knight can make 8 moves

**Answer B)** Implementing a hybrid approach that combines it with backtracking

**Q** What distinguishes a Hamiltonian cycle from a Hamiltonian Path?

- A) A Hamiltonian cycle includes all vertices exactly once, while a Hamiltonian path may repeat vertices.
- B) A Hamiltonian cycle forms a closed loop, while a Hamiltonian path does not return to the starting vertex.
- C) A Hamiltonian cycle only exists in directed graphs, while a Hamiltonian path exists in undirected graphs.
- D) There is no difference; both terms refer to the same concept.

**Answer B)** A Hamiltonian cycle forms a closed loop, while a Hamiltonian path does not return to the starting vertex.

**Q** In terms of computational complexity, the problem of finding a Hamiltonian cycle in a graph is classified as:

- A) P
- B) NP-hard
- C) NP-complete
- D) NP-complete

**Answer D)** NP-complete

**Q** Which algorithmic approach is typically ineffective for finding Hamiltonian cycles in large graphs due to its exponential time complexity?

- A) Dynamic programming
- B) Greedy algorithm
- C) Brute force
- D) Backtracking

**Answer C)** Brute force

**Q** In the context of Hamiltonian cycles, what is the significance of a "complete graph"?

- A) It guarantees the existence of a hamiltonian cycle.
- B) It finds the shortest possible path for the knight
- C) It uses less memory than brute force approaches
- D) It has a polynomial time complexity in comparison to the factorial time complexity of brute force methods

**Answer A)** It guarantees the existence of a hamiltonian cycle.

**Q** When applied to non-standard board sizes (not 8x8), what is the effect on the efficiency and effectiveness of Warnsdorff's algorithm?

- A) The algorithm becomes more efficient

**Answer B)** The algorithm's effectiveness can vary, sometimes failing to find a solution

**Q** What is a common technique to improve the performance of Warnsdorff's algorithm?

- A) Randomizing the initial knight's position

**Answer C)** Implementing a hybrid approach that combines it with backtracking

**Q** Answer B) It is a variation where the Hamiltonian cycle needs to have the minimum possible weight.

**Q** What is the Bondy-Chvatal theorem's contribution to the study of Hamiltonian cycles?

- A) It provides a polynomial-time algorithm to find Hamiltonian cycles.
- B) It states that a graph is Hamiltonian if the sum of the degrees of any two non-adjacent vertices is at least the number of vertices in the graph.
- C) It provides a necessary and sufficient condition for the existence of Hamiltonian cycles in plane graphs.
- D) It defines a method for transforming non-Hamiltonian graphs into Hamiltonian graphs.

**Answer B)** It states that a graph is Hamiltonian if the sum of the degrees of any two non-adjacent vertices is at least the number of vertices in the graph.

**Q** Kruskal's algorithm is used to:

- A) Find minimum spanning tree
- B) Find a source shortest path
- C) Find a pair shortest path algorithm
- D) Traverse the graph

**Answer A)** Find minimum spanning tree

**Q** Kruskal's algorithm is a \_\_\_\_\_

- A) Divide and conquer algorithm
- B) dynamic programming algorithm
- C) greedy algorithm
- D) approximation algorithm

**Answer C)** greedy algorithm

**Q** What is the weight of the minimum spanning tree using the Kruskal's algorithm?

**(Note: Without the graph, I can't determine the exact weight. Please provide the graph if needed.)**

**Q** Using Kruskal's algorithm, which edge will be selected first?

**(Note: Without the graph, I can't determine the correct edge. Please provide the graph if needed.)**

**Q** Which of the following is NOT a necessary condition for the existence of a Hamiltonian cycle in an unweighted graph?

- A) The graph must be connected.
- B) Every vertex must have at least two neighbors.
- C) The graph must be complete.
- D) The number of vertices with an odd degree must be even.

**Answer C)** The graph must be complete.

**Q** Consider Dirac's theorem in graph theory. What does it state regarding the hamiltonian cycle?

- A) A graph with  $n$  vertices is hamiltonian if every vertex has degree at least  $n^2/\ln(2n)$ .
- B) A graph with  $n$  vertices is hamiltonian if it contains an Eulerian cycle.
- C) A graph is hamiltonian if it contains a cycle of length  $n$ .
- D) A graph with  $n$  vertices is hamiltonian if the sum of the degrees of any two adjacent vertices is at least  $n$ .

**Answer A)** A graph with  $n$  vertices is called a "Hamiltonian circuit".

**Q** In directed graphs, what's a special type of Hamiltonian cycle is known to always contain a Hamiltonian cycle?

- A) A cycle that includes a specific set of edges
- B) A cycle that covers all vertices and edges
- C) A cycle that has at least one repeated vertex
- D) A directed cycle that includes every vertex exactly once

**Answer D)** A directed cycle that includes every vertex exactly once

**Q** Which of the following graph classes is known to always contain a Hamiltonian cycle?

- A) Planar graphs
- B) Bipartite graphs
- C) Complete graphs
- D) Trees

**Answer C)** Complete graphs

**Q** What is the Travelling Salesman Problem (TSP) in relation to the Hamiltonian cycle?

- A) It is a problem of finding a path that covers all vertices without repeating.
- B) It is a variation where the Hamiltonian cycle needs to have the minimum possible weight.
- C) It is a problem of finding a cycle that visits each vertex exactly twice.
- D) It requires finding the shortest path between two specific vertices.

**Answer B)** TSP in relation to the Hamiltonian cycle

**Q** Suppose two activities A and B, having start and finish time as SA, FA, and SB, FB respectively. Both the activities are said to be compatible, under which of the following conditions?

- A) SA = FB
- B) SA > FB
- C) SA or SB > FA
- D) SA and SB = FA

**Answer A)** Activities A and B are compatible if they share the same duration.

**Q** Consider the following algorithm to find the solution of the activity selection problem.

- A) Dynamic programming
- B) Greedy approach
- C) Depth-first search
- D) Breadth-first search

**Answer B)** Greedy approach

**Q** Suppose two activities A and B, having start and finish time as SA, FA, and SB, FB respectively. Both the activities are said to be compatible, under which of the following conditions?

- A) SA = FB
- B) SA > FB
- C) SA or SB > FA
- D) SA and SB = FA

**Answer A)** Activities A and B are compatible if they share the same duration.

**Q** Consider the following algorithm to find the solution of the activity selection problem.

- A) Sort the given activities list
- B) display the first activity
- C) discard the activity
- D) increment j

**Answer B)** display the jth activity

**Q** Consider the following options is best suited to fill the blank?

- A) True
- B) False
- C) Discard the activity
- D) Increment j

**Answer C)** Discard the activity

**Q** Which of the following number of activities with their start and finish time given below, in which a sequence will the activity be selected in order to maximize the number of activities, without any conflicts?

**Answer B)** False

**Q** Consider the following statements.

**Answer C)** Consider the following statements.

**Q** Consider the following algorithm:

**Answer D)** Kruskal's algorithm can be efficiently implemented using the disjoint-set data structure.

**Q** Which of the following approaches should be used to find the solution of the activity selection problem?

- A) Greedy approach
- B) Divide and conquer
- C) Brute-force approach

**Answer B)** Greedy approach

**Q** What is the time complexity of the activity selection problem takes O(n log n)

**Q** Time complexity to find the solution of the activity selection problem takes O(n log n)

**Q** If the list is not sorted.

**Answer A)** True

**Answer B)** False

**Q** Answer: B) False

**Q** Answer: C) False

**Q** Answer: D) False

**Q** Answer: E) False

**Q** The solution of the activity selection problem can have two overlapping activities in a particular time interval.

**Answer A)** True

6. In edge coloring of a graph, what is the minimum number of colors required to color the edges such that no two adjacent edges share the same color called?
- A) Chromatic index
  - B) Chromatic number
  - C) Coloring number
  - D) Degree of the graph
7. Consider the following number of activities with their start and finish time given below.  
Which of the following activity will be left out?  
(Note: Without the graph, can't determine the correct activity. Please provide the graph if needed.)
8. Which among the following represents best-case time complexity for the activity selection problem?
- A)  $O(n)$
  - B)  $O(1)$
  - C)  $O(n)$
  - D)  $O(n * \log n)$
- Answer: A)  $O(n)$  (Best case complexity when the activities are already sorted).
9. Which of the following problems can be solved by a standard greedy algorithm?
- I. Finding a minimum cost spanning tree in an undirected graph.
  - II. Finding a single maximal clique in a graph.
  - III. Finding the longest common subsequence in a given string.
  - IV.  $A \cup B$
  - V.  $B \setminus (A \cap B)$
  - VI.  $I_1 \cup I_2 \cup \dots \cup I_n$
  - VII.  $I_1 \cap I_2 \cap \dots \cap I_n$
- Answer: D) only (A minimum cost spanning tree can be solved with a greedy algorithm, but the other problems require different approaches).
10. The minimum number of colors with which we can guarantee that no two adjacent nodes will have the same color if we want to color the nodes of any cycle is:
- A) 2
  - B) 3
  - C) 4
  - D)  $n+2$
- Answer: A) 2 (For any cycle, 2 colors are sufficient, as the cycle is bipartite).
1. What is the minimum number of colors required to color a graph such that no two adjacent vertices have the same color called?
- A) Chromatic number
2. In a graph, what is the condition for two vertices to be assigned different colors in a proper vertex coloring?
- A) The vertices must have the same degree.
  - B) The vertices must be adjacent.
  - C) The vertices must be at an even distance from each other.
  - D) The vertices must belong to different connected components.
3. Which of the following statements is true for a bipartite graph regarding vertex coloring?
- A) It can be colored with three colors.
  - B) It can be colored with two colors.
  - C) It cannot be properly colored.
  - D) It requires more colors than the chromatic number.
- Answer: B) It can be colored with two colors.
4. What is the chromatic number of a complete graph on with  $n$  vertices?
- A) 1
  - B) 2
  - C)  $n$
  - D)  $n+1$
- Answer: C)  $n$  (Each vertex must be assigned a different color in a complete graph, so the chromatic number is  $n$ ).
5. Which algorithm is commonly used for finding an approximate solution to the vertex coloring problem in polynomial time?
- A) Breadth-First search (BFS)
  - B) Depth first search (DFS)
  - C) Greedy coloring algorithm
  - D) Dijkstra's algorithm
  - E) Answer: C) Greedy coloring algorithm
6. In edge coloring of a graph, what is the minimum number of colors required to color the edges such that no two adjacent edges share the same color called?
- A) Chromatic index
  - B) Chromatic number
  - C) Coloring number
  - D) Edge chromatic number
- Answer: C) Edge chromatic number
7. What is the maximum number of colors required to color the edges of any simple graph  $G$  according to Vizing's theorem?
- A)  $\Delta(G) + 1$ , where  $\Delta(G)$  is the maximum degree of the graph
  - B)  $\Delta(G) + 1$
  - C)  $\lceil \Delta(G)/2 \rceil$
  - D)  $\Delta(G)$
- Answer: A)  $\Delta(G) + 1$
8. What type of graph always requires at least three colors for proper coloring?
- A) Planar graph
  - B) Bipartite graph
  - C) Non-bipartite graph
  - D) Cycle graph with an odd number of vertices
- Answer: D) Cycle graph with an odd number of vertices
9. What is the Four Color Theorem related to graph coloring?
- A) It states that any planar graph can be colored with at most four colors.
  - B) It states that any graph can be colored with four colors.
  - C) It states that a graph requires at least four colors if it contains a complete subgraph with four vertices.
  - D) It provides a method to color graphs using four different algorithms.
- Answer: A) It states that any planar graph can be colored with at most four colors.
10. What is an NP-complete problem related to graph coloring?
- A) Determining the chromatic number of a graph
  - B) Finding a Hamiltonian cycle in a graph
  - C) Finding the shortest path between two vertices
  - D) Determining if a graph is bipartite
11. In Java networking, which exception is commonly thrown for socket-related errors?
- A) IOException
  - B) NullPointerException
  - C) SQLException
  - D) ClassNotFoundException
- Answer: A) IOException
12. Which class is used to create a server-side socket in Java?
- A) ServerSocket
  - B) Socket
  - C) DatagramSocket
  - D) InetAddress
- Answer: A) ServerSocket
13. Which method is used to accept a connection from a client in the `ServerSocket` class?
- A) connect()
  - B) bind()
  - C) accept()
  - D) listen()
- Answer: C) accept()
14. Which class in Java is used for client-side socket programming?
- A) ServerSocket
  - B) Socket
  - C) DatagramSocket
  - D) InetAddress
- Answer: B) Socket
15. Which protocol is typically used with `DatagramSocket` in Java?
- A) TCP
  - B) FTP
  - C) HTTP
  - D) UDP
- Answer: D) UDP
16. Which class in Java provides methods to work with IP addresses?
- A) `InetAddress`
  - B) `IP`
  - C) `HTTP`
  - D) `IP`
- Answer: A) `InetAddress`
17. What is the primary purpose of Huffman Coding?
- A) Sorting elements in an array
  - B) Using a binary search tree
  - C) Data compression
  - D) Searching for an element in a list
- Answer: C) Data compression
18. In Huffman Coding, how is the frequency of characters represented?
- A)  $O(n)$
  - B)  $O(\log n)$
  - C)  $O(n^2)$
  - D)  $O(\log \log n)$
- Answer: B)  $O(\log n)$
19. When constructing the Huffman Tree, what happens to the two nodes with the lowest frequencies?
- A) Stack
  - B) PriorityQueue
  - C) ArrayList
  - D) LinkedList
- Answer: B) Count the frequency of each character
20. What is the time complexity of building a Huffman Tree?
- A)  $O(n)$
  - B)  $O(n \log n)$
  - C)  $O(n^2)$
  - D)  $O(\log n)$
- Answer: A)  $O(n)$
21. What is the output of the Huffman Coding algorithm?
- A) A binary search tree
  - B) They are discarded
  - C) Their frequencies are swapped
  - D) They are kept as leaf nodes
- Answer: A) They are merged to form a new internal node
22. Answer: C) Using a min-heap
23. When constructing the Huffman Tree, what happens to the two nodes with the lowest frequencies?
- A) A binary search tree
  - B) They are discarded
  - C) Their frequencies are swapped
  - D) They are kept as leaf nodes
- Answer: A) They are merged to form a new internal node
24. Answer: C) Using a Huffman Tree and a table of codes
- A) An array
  - B) An encoded string
  - C) A Huffman Tree and a table of codes
  - D) A sorted array
- Answer: B) An encoded string
25. In Huffman Coding, what is the property of the generated codes?
- A) All codes have the same length
  - B) Codes are prefix-free
  - C) Codes are suffix-free
  - D) Codes are generated randomly
- Answer: B) Data compression

- A) Socket
- B) ServerSocket
- C) InetAddress
- D) DatagramPacket

**Answer: C) InetAddress**

**Which method of the Socket class is used to get the input stream for reading data from the socket?**

- A) getOutputStream()
  - B) getInputStream()
  - C) connect()
  - D) close()
- Answer: B) getInputStream()**
- Which method of the Socket class is used to send data to the socket?**
- A) getInputStream()
  - B) getOutputStream()
  - C) send()
  - D) write()
- Answer: B) getOutputStream()**
- What is the default port number for HTTP?**
- A) 21
  - B) 25
  - C) 80
  - D) 443
- Answer: C) 80**
- Which of the following is not a valid constructor for the DatagramPacket class?**
- A) DatagramPacket(byte[] buf, int length)
  - B) DatagramPacket(byte[] buf, int offset, int length)
  - C) DatagramPacket(byte[] buf, int length, InetAddress address, int port)
  - D) DatagramPacket(byte[] buf, InetAddress address, int port)
- Answer: D) DatagramPacket(byte[] buf, InetAddress address, int port)**
- What is the primary purpose of encryption in Java applications?**

- a) To improve application performance
- b) To compress data for storage efficiency
- c) To represent a secret (symmetric) key used in encryption
- d) To manage key pairs for asymmetric encryption

**Answer: c) To represent a secret (symmetric) key used in encryption**

**Which method of the Cipher class initializes the cipher for encryption or decryption?**

- a) init()
  - b) start()
  - c) setup()
  - d) initialize()
- Answer: a) init()**
- How can you convert a byte array to a hexadecimal string in Java?**
- a) Using the BigInteger class
  - b) Using the Hex class
  - c) Using the Arrays class
  - d) Using the DatagramPacket class
- Answer: b) Using the Hex class**
- What is a common block cipher mode of operation used with the AES algorithm in Java?**
- a) ECB (Electronic Codebook)
  - b) CBC (Cipher Block Chaining)
  - c) OFB (Output Feedback)
  - d) CFB (Cipher Feedback)
- Answer: b) CBC (Cipher Block Chaining)**
- Which method of the Cipher class is used to perform the actual encryption or decryption?**
- a) doFinal()
  - b) update()
  - c) process()
  - d) execute()
- Answer: a) doFinal()**
- Which library provides cryptographic operations, including encryption and decryption?**
- a) java.util
  - b) java.io
  - c) java.security
  - d) java.net
- Answer: c) java.security**
- What is the role of the SecretKey interface in Java?**
- a) To generate random numbers