

1. Consider the following code segment.

```
for (int k = 0; k < 20; k = k + 2)
{
    if (k % 3 == 1)
    {
        System.out.print(k + " ");
    }
}
```

What is printed as a result of executing the code segment?

- (A) 4 16
- (B) 4 10 16
- (C) 0 6 12 18
- (D) 1 4 7 10 13 16 19
- (E) 0 2 4 6 8 10 12 14 16 18

2. Consider the following code segment.

```
List<String> animals = new ArrayList<String>();

animals.add("dog");
animals.add("cat");
animals.add("snake");
animals.set(2, "lizard");
animals.add(1, "fish");
animals.remove(3);
System.out.println(animals);
```

What is printed as a result of executing the code segment?

- (A) [dog, fish, cat]
- (B) [dog, fish, lizard]
- (C) [dog, lizard, fish]
- (D) [fish, dog, cat]
- (E) The code throws an `ArrayIndexOutOfBoundsException` exception.

3. Consider the following method.

```
public static void mystery(List<Integer> nums)
{
    for (int k = 0; k < nums.size(); k++)
    {
        if (nums.get(k).intValue() == 0)
        {
            nums.remove(k);
        }
    }
}
```

Assume that a `List<Integer> values` initially contains the following Integer values.

[0, 0, 4, 2, 5, 0, 3, 0]

What will `values` contain as a result of executing `mystery(values)` ?

- (A) [0, 0, 4, 2, 5, 0, 3, 0]
- (B) [4, 2, 5, 3]
- (C) [0, 0, 0, 0, 4, 2, 5, 3]
- (D) [0, 4, 2, 5, 3]
- (E) The code throws an `ArrayIndexOutOfBoundsException` exception.

4. At a certain high school students receive letter grades based on the following scale.

<u>Integer Score</u>	<u>Letter Grade</u>
93 or above	A
From 84 to 92 inclusive	B
From 75 to 83 inclusive	C
Below 75	F

Which of the following code segments will assign the correct string to `grade` for a given integer `score` ?

I.

```
if (score >= 93)
    grade = "A";
if (score >= 84 && score <= 92)
    grade = "B";
if (score >= 75 && score <= 83)
    grade = "C";
if (score < 75)
    grade = "F";
```

II.

```
if (score >= 93)
    grade = "A";
if (84 <= score <= 92)
    grade = "B";
if (75 <= score <= 83)
    grade = "C";
if (score < 75)
    grade = "F";
```

III.

```
if (score >= 93)
    grade = "A";
else if (score >= 84)
    grade = "B";
else if (score >= 75)
    grade = "C";
else
    grade = "F";
```

- (A) II only
- (B) III only
- (C) I and II only
- (D) I and III only
- (E) I, II, and III

5. Consider the following output.

```
1  1  1  1  1
2  2  2  2
3  3  3
4  4
5
```

Which of the following code segments will produce this output?

- (A)

```
for (int j = 1; j <= 5; j++)
{
    for (int k = 1; k <= 5; k++)
    {
        System.out.print(j + " ");
    }
    System.out.println();
}
```
- (B)

```
for (int j = 1; j <= 5; j++)
{
    for (int k = 1; k <= j; k++)
    {
        System.out.print(j + " ");
    }
    System.out.println();
}
```
- (C)

```
for (int j = 1; j <= 5; j++)
{
    for (int k = 5; k >= 1; k--)
    {
        System.out.print(j + " ");
    }
    System.out.println();
}
```
- (D)

```
for (int j = 1; j <= 5; j++)
{
    for (int k = 5; k >= j; k--)
    {
        System.out.print(j + " ");
    }
    System.out.println();
}
```
- (E)

```
for (int j = 1; j <= 5; j++)
{
    for (int k = j; k <= 5; k++)
    {
        System.out.print(k + " ");
    }
    System.out.println();
}
```

6. A car dealership needs a program to store information about the cars for sale. For each car, they want to keep track of the following information: number of doors (2 or 4), whether the car has air conditioning, and its average number of miles per gallon. Which of the following is the best object-oriented program design?
- (A) Use one class, `Car`, with three instance variables:
`int numDoors`, `boolean hasAir`, and `double milesPerGallon`.
 - (B) Use four unrelated classes: `Car`, `Doors`, `AirConditioning`, and `MilesPerGallon`.
 - (C) Use a class `Car` with three subclasses: `Doors`, `AirConditioning`, and `MilesPerGallon`.
 - (D) Use a class `Car`, with a subclass `Doors`, with a subclass `AirConditioning`, with a subclass `MilesPerGallon`.
 - (E) Use three classes: `Doors`, `AirConditioning`, and `MilesPerGallon`, each with a subclass `Car`.
7. Consider the following declarations.

```
public interface Shape
{
    int isLargerThan(Shape other);
    // Other methods not shown
}
public class Circle implements Shape
{
    // Other methods not shown
}
```

Which of the following method headings of `isLargerThan` can be added to the declaration of the `Circle` class so that it will satisfy the `Shape` interface?

- I. `public int isLargerThan(Shape other)`
 - II. `public int isLargerThan(Circle other)`
 - III. `public boolean isLargerThan(Object other)`
- (A) I only
 - (B) II only
 - (C) III only
 - (D) I and II only
 - (E) I, II, and III

Questions 8–9 refer to the following incomplete class declaration.

```
public class TimeRecord
{
    private int hours;
    private int minutes; // 0 ≤ minutes < 60
    /** Constructs a TimeRecord object.
     *  @param h the number of hours
     *          Precondition:  $h \geq 0$ 
     *  @param m the number of minutes
     *          Precondition:  $0 \leq m < 60$ 
     */
    public TimeRecord(int h, int m)
    {
        hours = h;
        minutes = m;
    }

    /** @return the number of hours
     */
    public int getHours()
    { /* implementation not shown */ }

    /** @return the number of minutes
     *  Postcondition:  $0 \leq \text{minutes} < 60$ 
     */
    public int getMinutes()
    { /* implementation not shown */ }

    /** Adds h hours and m minutes to this TimeRecord.
     *  @param h the number of hours
     *          Precondition:  $h \geq 0$ 
     *  @param m the number of minutes
     *          Precondition:  $m \geq 0$ 
     */
    public void advance(int h, int m)
    {
        hours = hours + h;
        minutes = minutes + m;
        /* missing code */
    }
    // Other methods not shown
}
```

8. Which of the following can be used to replace */* missing code */* so that `advance` will correctly update the time?
- (A) `minutes = minutes % 60;`
 - (B) `minutes = minutes + hours % 60;`
 - (C) `hours = hours + minutes / 60;`
`minutes = minutes % 60;`
 - (D) `hours = hours + minutes % 60;`
`minutes = minutes / 60;`
 - (E) `hours = hours + minutes / 60;`
9. Consider the following declaration that appears in a class other than `TimeRecord`.

```
TimeRecord[] timeCards = new TimeRecord[100];
```

Assume that `timeCards` has been initialized with `TimeRecord` objects. Consider the following code segment that is intended to compute the total of all the times stored in `timeCards`.

```
TimeRecord total = new TimeRecord(0,0);
for (int k = 0; k < timeCards.length; k++)
{
    /* missing expression */ ;
}
```

Which of the following can be used to replace */* missing expression */* so that the code segment will work as intended?

- (A) `timeCards[k].advance()`
- (B) `total += timeCards[k].advance()`
- (C) `total.advance(timeCards[k].hours,`
`timeCards[k].minutes)`
- (D) `total.advance(timeCards[k].getHours(),`
`timeCards[k].getMinutes())`
- (E) `timeCards[k].advance(timeCards[k].getHours(),`
`timeCards[k].getMinutes())`

10. Consider the following instance variable and method.

```
private int[] arr;

/** Precondition: arr contains no duplicates;
 *           the elements in arr are in ascending order.
 * @param low an int value such that  $0 \leq \text{low} \leq \text{arr.length}$ 
 * @param high an int value such that  $\text{low} - 1 \leq \text{high} < \text{arr.length}$ 
 * @param num an int value
 */
public int mystery(int low, int high, int num)
{
    int mid = (low + high) / 2;
    if (low > high)
    {
        return low;
    }
    else if (arr[mid] < num)
    {
        return mystery(mid + 1, high, num);
    }
    else if (arr[mid] > num)
    {
        return mystery(low, mid - 1, num);
    }
    else // arr[mid] == num
    {
        return mid;
    }
}
```

What is returned by the call `mystery(0, arr.length - 1, num)`?

- (A) The number of elements in `arr` that are less than `num`
- (B) The number of elements in `arr` that are less than or equal to `num`
- (C) The number of elements in `arr` that are equal to `num`
- (D) The number of elements in `arr` that are greater than `num`
- (E) The index of the middle element in `arr`

Questions 11–12 refer to the following information.

Consider the following instance variable `nums` and method `findLongest` with line numbers added for reference. Method `findLongest` is intended to find the longest consecutive block of the value `target` occurring in the array `nums`; however, `findLongest` does not work as intended.

For example, if the array `nums` contains the values [7, 10, 10, 15, 15, 15, 15, 10, 10, 10, 15, 10, 10], the call `findLongest(10)` should return 3, the length of the longest consecutive block of 10s.

```
private int[] nums;

public int findLongest(int target)
{
    int lenCount = 0;
    int maxLen = 0;

Line 1:   for (int val : nums)
Line 2:   {
Line 3:       if (val == target)
Line 4:       {
Line 5:           lenCount++;
Line 6:       }
Line 7:       else
Line 8:       {
Line 9:           if (lenCount > maxLen)
Line 10:          {
Line 11:              maxLen = lenCount;
Line 12:          }
Line 13:      }
Line 14:  }
Line 15:  if (lenCount > maxLen)
Line 16:  {
Line 17:      maxLen = lenCount;
Line 18:  }
Line 19:  return maxLen;
}
```

11. The method `findLongest` does not work as intended. Which of the following best describes the value returned by a call to `findLongest` ?
- (A) It is the length of the shortest consecutive block of the value `target` in `nums`.
 - (B) It is the length of the array `nums`.
 - (C) It is the number of occurrences of the value `target` in `nums`.
 - (D) It is the length of the first consecutive block of the value `target` in `nums`.
 - (E) It is the length of the last consecutive block of the value `target` in `nums`.
12. Which of the following changes should be made so that method `findLongest` will work as intended?
- (A) Insert the statement `lenCount = 0;` between lines 2 and 3.
 - (B) Insert the statement `lenCount = 0;` between lines 8 and 9.
 - (C) Insert the statement `lenCount = 0;` between lines 10 and 11.
 - (D) Insert the statement `lenCount = 0;` between lines 11 and 12.
 - (E) Insert the statement `lenCount = 0;` between lines 12 and 13.

13. Consider the following instance variable and method.

```
private int[] numbers;

/** Precondition: numbers contains int values in no particular order.
 */
public int mystery(int num)
{
    for (int k = numbers.length - 1; k >= 0; k--)
    {
        if (numbers[k] < num)
        {
            return k;
        }
    }
    return -1;
}
```

Which of the following best describes the contents of `numbers` after the following statement has been executed?

```
int m = mystery(n);
```

- (A) All values in positions 0 through `m` are less than `n`.
- (B) All values in positions `m+1` through `numbers.length-1` are less than `n`.
- (C) All values in positions `m+1` through `numbers.length-1` are greater than or equal to `n`.
- (D) The smallest value is at position `m`.
- (E) The largest value that is smaller than `n` is at position `m`.

14. Consider the following method.

```
/** @param x an int value such that x >= 0
 */
public void mystery(int x)
{
    System.out.print(x % 10);
    if ((x / 10) != 0)
    {
        mystery(x / 10);
    }
    System.out.print(x % 10);
}
```

Which of the following is printed as a result of the call `mystery(1234)`?

- (A) 1234
- (B) 4321
- (C) 12344321
- (D) 43211234
- (E) Many digits are printed due to infinite recursion.

15. Consider the following two classes.

```
public class Dog
{
    public void act()
    {
        System.out.print("run ");
        eat();
    }
    public void eat()
    {
        System.out.print("eat ");
    }
}

public class UnderDog extends Dog
{
    public void act()
    {
        super.act();
        System.out.print("sleep ");
    }
    public void eat()
    {
        super.eat();
        System.out.print("bark ");
    }
}
```

Assume that the following declaration appears in a class other than `Dog`.

```
Dog fido = new UnderDog();
```

What is printed as a result of the call `fido.act()` ?

- (A) run eat
- (B) run eat sleep
- (C) run eat sleep bark
- (D) run eat bark sleep
- (E) Nothing is printed due to infinite recursion.

16. Consider the following recursive method.

```
public static int mystery(int n)
{
    if (n <= 1)
    {
        return 0;
    }
    else
    {
        return 1 + mystery(n / 2);
    }
}
```

Assuming that k is a nonnegative integer and $m = 2^k$, what value is returned as a result of the call `mystery(m)` ?

- (A) 0
- (B) k
- (C) m
- (D) $\frac{m}{2} + 1$
- (E) $\frac{k}{2} + 1$

17. Consider the following instance variable and method.

```
private int[] array;

/** Precondition: array.length > 0
 */
public int checkArray()
{
    int loc = array.length / 2;
    for (int k = 0; k < array.length; k++)
    {
        if (array[k] > array[loc])
        {
            loc = k;
        }
    }
    return loc;
}
```

Which of the following is the best postcondition for `checkArray` ?

- (A) Returns the index of the first element in array `array` whose value is greater than `array[loc]`
- (B) Returns the index of the last element in array `array` whose value is greater than `array[loc]`
- (C) Returns the largest value in array `array`
- (D) Returns the index of the largest value in array `array`
- (E) Returns the index of the largest value in the second half of array `array`

18. Consider the following methods.

```
public void changer(String x, int y)
{
    x = x + "peace";
    y = y * 2;
}

public void test()
{
    String s = "world";
    int n = 6;
    changer(s, n);

    /* End of method */
}
```

When the call `test()` is executed, what are the values of `s` and `n` at the point indicated by `/* End of method */` ?

<u>s</u>	<u>n</u>
(A) world	6
(B) worldpeace	6
(C) world	12
(D) worldpeace	12
(E) peace	12

19. Consider the following code segment.

```
int[] [] mat = new int[3][4];
for (int row = 0; row < mat.length; row++)
{
    for (int col = 0; col < mat[0].length; col++)
    {
        if (row < col)
        {
            mat[row][col] = 1;
        }
        else if (row == col)
        {
            mat[row][col] = 2;
        }
        else
        {
            mat[row][col] = 3;
        }
    }
}
```

What are the contents of `mat` after the code segment has been executed?

- (A) $\{\{2, 1, 1\},$
 $\{3, 2, 1\},$
 $\{3, 3, 2\},$
 $\{3, 3, 3\}\}$
- (B) $\{\{2, 3, 3\},$
 $\{1, 2, 3\},$
 $\{1, 1, 2\},$
 $\{1, 1, 1\}\}$
- (C) $\{\{2, 3, 3, 3\},$
 $\{1, 2, 3, 3\},$
 $\{1, 1, 2, 3\}\}$
- (D) $\{\{2, 1, 1, 1\},$
 $\{3, 2, 1, 1\},$
 $\{3, 3, 2, 1\}\}$
- (E) $\{\{1, 1, 1, 1\},$
 $\{2, 2, 2, 2\},$
 $\{3, 3, 3, 3\}\}$

20. Consider the following method.

```

/** Precondition: arr contains only positive values.
 */
public static void doSome(int[] arr, int lim)
{
    int v = 0;
    int k = 0;
    while (k < arr.length && arr[k] < lim)
    {
        if (arr[k] > v)
        {
            v = arr[k]; /* Statement S */
        }
        k++; /* Statement T */
    }
}

```

Assume that `doSome` is called and executes without error. Which of the following are possible combinations for the value of `lim`, the number of times *Statement S* is executed, and the number of times *Statement T* is executed?

	Value of <u>lim</u>	Executions of <u><i>Statement S</i></u>	Executions of <u><i>Statement T</i></u>
I.	5	0	5
II.	7	4	9
III.	3	5	2

- (A) I only
- (B) II only
- (C) III only
- (D) I and III only
- (E) II and III only

21. Consider the following instance variable, `arr`, and incomplete method, `partialSum`. The method is intended to return an integer array `sum` such that for all `k`, `sum[k]` is equal to `arr[0] + arr[1] + ... + arr[k]`. For instance, if `arr` contains the values `{ 1, 4, 1, 3 }`, the array `sum` will contain the values `{ 1, 5, 6, 9 }`.

```
private int[] arr;
public int[] partialSum()
{
    int[] sum = new int[arr.length];
    for (int j = 0; j < sum.length; j++)
    {
        sum[j] = 0;
    }
    /* missing code */
    return sum;
}
```

The following two implementations of `/* missing code */` are proposed so that `partialSum` will work as intended.

Implementation 1

```
for (int j = 0; j < arr.length; j++)
{
    sum[j] = sum[j - 1] + arr[j];
}
```

Implementation 2

```
for (int j = 0; j < arr.length; j++)
{
    for (int k = 0; k <= j; k++)
    {
        sum[j] = sum[j] + arr[k];
    }
}
```

Which of the following statements is true?

- (A) Both implementations work as intended, but implementation 1 is faster than implementation 2.
- (B) Both implementations work as intended, but implementation 2 is faster than implementation 1.
- (C) Both implementations work as intended and are equally fast.
- (D) Implementation 1 does not work as intended, because it will cause an `ArrayIndexOutOfBoundsException`.
- (E) Implementation 2 does not work as intended, because it will cause an `ArrayIndexOutOfBoundsException`.

22. Consider the following declaration for a class that will be used to represent points in the xy -coordinate plane.

```
public class Point
{
    private int x;        // x-coordinate of the point
    private int y;        // y-coordinate of the point

    public Point()
    {
        x = 0;
        y = 0;
    }

    public Point(int a, int b)
    {
        x = a;
        y = b;
    }

    // Other methods not shown
}
```

The following incomplete class declaration is intended to extend the above class so that points can be named.

```
public class NamedPoint extends Point
{
    private String name; // name of point

    // Constructors go here

    // Other methods not shown
}
```

Consider the following proposed constructors for this class.

- I.

```
public NamedPoint()  
{  
    name = "";  
}
```
- II.

```
public NamedPoint(int d1, int d2, String pointName)  
{  
    x = d1;  
    y = d2;  
    name = pointName;  
}
```
- III.

```
public NamedPoint(int d1, int d2, String pointName)  
{  
    super(d1, d2);  
    name = pointName;  
}
```

Which of these constructors would be legal for the `NamedPoint` class?

- (A) I only
- (B) II only
- (C) III only
- (D) I and III only
- (E) II and III only

23. Consider a `shuffle` method that is intended to return a new array that contains all the elements from `nums`, but in a different order. Let `n` be the number of elements in `nums`. The `shuffle` method should alternate the elements from `nums[0] ... nums[n / 2 - 1]` with the elements from `nums[n / 2] ... nums[n - 1]`, as illustrated in the following examples.

Example 1

	0	1	2	3	4	5	6	7
nums	10	20	30	40	50	60	70	80
	0	1	2	3	4	5	6	7
result	10	50	20	60	30	70	40	80

Example 2

	0	1	2	3	4	5	6
nums	10	20	30	40	50	60	70
	0	1	2	3	4	5	6
result	10	40	20	50	30	60	70

The following implementation of the `shuffle` method does not work as intended.

```
public static int[] shuffle(int[] nums)
{
    int n = nums.length;
    int[] result = new int[n];

    for (int j = 0; j < n / 2; j++)
    {
        result[j * 2] = nums[j];
        result[j * 2 + 1] = nums[j + n / 2];
    }

    return result;
}
```

Which of the following best describes the problem with the given implementation of the `shuffle` method?

- (A) Executing `shuffle` may cause an `ArrayIndexOutOfBoundsException`.
- (B) The first element of the returned array (`result[0]`) may not have the correct value.
- (C) The last element of the returned array (`result[result.length - 1]`) may not have the correct value.
- (D) One or more of `nums[0] ... nums[nums.length / 2 - 1]` may have been copied to the wrong position(s) in the returned array.
- (E) One or more of `nums[nums.length / 2] ... nums[nums.length - 1]` may have been copied to the wrong position(s) in the returned array.

24. Consider the following `Util` class, which contains two methods. The completed `sum1D` method returns the sum of all the elements of the 1-dimensional array `a`. The incomplete `sum2D` method is intended to return the sum of all the elements of the 2-dimensional array `m`.

```
public class Util
{
    /** Returns the sum of the elements of the 1-dimensional array a */
    public static int sum1D(int[] a)
    { /* implementation not shown */ }

    /** Returns the sum of the elements of the 2-dimensional array m */
    public static int sum2D(int[][] m)
    {
        int sum = 0;

        /* missing code */

        return sum;
    }
}
```

Assume that `sum1D` works correctly. Which of the following can replace `/* missing code */` so that the `sum2D` method works correctly?

- I.

```
for (int k = 0; k < m.length; k++)
{
    sum += sum1D(m[k]);
}
```
- II.

```
for (int[] row : m)
{
    sum += sum1D(row);
}
```
- III.

```
for (int[] row : m)
{
    for (int v : row)
    {
        sum += v;
    }
}
```

- (A) I only
- (B) II only
- (C) I and II only
- (D) II and III only
- (E) I, II, and III

25. The following `sort` method correctly sorts the integers in `elements` into ascending order.

```
Line 1:  public static void sort(int[] elements)
Line 2:  {
Line 3:      for (int j = 0; j < elements.length - 1; j++)
Line 4:      {
Line 5:          int index = j;
Line 6:
Line 7:          for (int k = j + 1; k < elements.length; k++)
Line 8:          {
Line 9:              if (elements[k] < elements[index])
Line 10:             {
Line 11:                 index = k;
Line 12:             }
Line 13:         }
Line 14:
Line 15:         int temp = elements[j];
Line 16:         elements[j] = elements[index];
Line 17:         elements[index] = temp;
Line 18:     }
Line 19: }
```


Which of the following changes to the `sort` method would correctly sort the integers in `elements` into **descending** order?

I. Replace line 9 with:

Line 9: `if (elements[k] > elements[index])`

II. Replace lines 15–17 with:

Line 15: `int temp = elements[index];`

Line 16: `elements[index] = elements[j];`

Line 17: `elements[j] = temp;`

III. Replace line 3 with:

Line 3: `for (int j = elements.length - 1; j > 0; j--)`

and replace line 7 with:

Line 7: `for (int k = 0; k < j; k++)`

- (A) I only
- (B) II only
- (C) I and II only
- (D) I and III only
- (E) I, II, and III