Section I

Multiple-Choice Questions

COMPUTER SCIENCE A

SECTION I

Time—1 hour and 30 minutes

Number of questions—40

Percent of total grade—50

Directions: Determine the answer to each of the following questions or incomplete statements, using the available space for any necessary scratch work. Then decide which is the best of the choices given and fill in the corresponding box on the student answer sheet. No credit will be given for anything written in the examination booklet. Do not spend too much time on any one problem.

Notes:

- Assume that the classes listed in the Java Quick Reference have been imported where appropriate.
- Assume that declarations of variables and methods appear within the context of an enclosing class.
- Assume that method calls that are not prefixed with an object or class name and are not shown within a complete class definition appear within the context of an enclosing class.
- Unless otherwise noted in the question, assume that parameters in method calls are not `null` and that methods are called only when their preconditions are satisfied.

GO ON TO THE NEXT PAGE.

1. Consider the following method.

```
public static int mystery(int[] arr)
{
  int x = 0;

  for (int k = 0; k < arr.length; k = k + 2)
    x = x + arr[k];

  return x;
}
```

Assume that the array `nums` has been declared and initialized as follows.

```
int[] nums = {3, 6, 1, 0, 1, 4, 2};
```

What value will be returned as a result of the call `mystery(nums)` ?

(A) 5

(B) 6

(C) 7

(D) 10

(E) 17

Questions 2-3 refer to the following information.

Consider the following partial class declaration.

```
public class SomeClass
{
  private int myA;
  private int myB;
  private int myC;

  // Constructor(s) not shown

  public int getA()
  {  return myA;  }

  public void setB(int value)
  {  myB = value;  }
}
```

2. The following declaration appears in another class.

```
SomeClass obj = new SomeClass();
```

Which of the following code segments will compile without error?

(A)
```
int x = obj.getA();
```

(B)
```
int x;
obj.getA(x);
```

(C)
```
int x = obj.myA;
```

(D)
```
int x = SomeClass.getA();
```

(E)
```
int x = getA(obj);
```

---

3. Which of the following changes to `SomeClass` will allow other classes to access but not modify the value of `myC` ?

(A) Make `myC` public.

(B) Include the method:
```
public int getC()
{  return myC;  }
```

(C) Include the method:
```
private int getC()
{  return myC;  }
```

(D) Include the method:
```
public void getC(int x)
{  x = myC;  }
```

(E) Include the method:
```
private void getC(int x)
{  x = myC;  }
```

GO ON TO THE NEXT PAGE.

4. Consider the following code segment.

```
int x = 7;
int y = 3;

if ((x < 10) && (y < 0))
  System.out.println("Value is: " + x * y);
else
  System.out.println("Value is: " + x / y);
```

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

(A) `Value is: 21`

(B) `Value is: 2.3333333`

(C) `Value is: 2`

(D) `Value is: 0`

(E) `Value is: 1`

5. Consider the following method.

```
public ArrayList<Integer> mystery(int n)
{
  ArrayList<Integer> seq = new ArrayList<Integer>();

  for (int k = 1; k <= n; k++)
    seq.add(new Integer(k * k + 3));

  return seq;
}
```

Which of the following is printed as a result of executing the following statement?

```
System.out.println(mystery(6));
```

(A) `[3, 4, 7, 12, 19, 28]`

(B) `[3, 4, 7, 12, 19, 28, 39]`

(C) `[4, 7, 12, 19, 28, 39]`

(D) `[39, 28, 19, 12, 7, 4]`

(E) `[39, 28, 19, 12, 7, 4, 3]`

6. Consider the following method that is intended to determine if the `double` values `d1` and `d2` are close enough to be considered equal. For example, given a `tolerance` of `0.001`, the values `54.32271` and `54.32294` would be considered equal.

```
/** @return true if d1 and d2 are within the specified tolerance,
 *          false otherwise
 */
public boolean almostEqual(double d1, double d2, double tolerance)
{
  /* missing code */
}
```

Which of the following should replace `/* missing code */` so that `almostEqual` will work as intended?

(A) `return (d1 - d2) <= tolerance;`

(B) `return ((d1 + d2) / 2) <= tolerance;`

(C) `return (d1 - d2) >= tolerance;`

(D) `return ((d1 + d2) / 2) >= tolerance;`

(E) `return Math.abs(d1 - d2) <= tolerance;`

7. Consider the following class declaration.

```
public class Person
{
  private String myName;
  private int myYearOfBirth;

  public Person(String name, int yearOfBirth)
  {
    myName = name;
    myYearOfBirth = yearOfBirth;
  }

  public String getName()
  {  return myName;  }

  public void setName(String name)
  {  myName = name;  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

Assume that the following declaration has been made.

```
Person student = new Person("Thomas", 1995);
```

Which of the following statements is the most appropriate for changing the name of `student` from `"Thomas"` to `"Tom"` ?

(A) `student = new Person("Tom", 1995);`

(B) `student.myName = "Tom";`

(C) `student.getName("Tom");`

(D) `student.setName("Tom");`

(E) `Person.setName("Tom");`

8. Consider the following class declaration.

```
public class Student
{
  private String myName;
  private int myAge;

  public Student()
  {  /* implementation not shown */  }

  public Student(String name, int age)
  {  /* implementation not shown */  }

  // No other constructors
}
```

Which of the following declarations will compile without error?

I. `Student a = new Student();`

II. `Student b = new Student("Juan", 15);`

III. `Student c = new Student("Juan", "15");`

(A) I only

(B) II only

(C) I and II only

(D) I and III only

(E) I, II, and III

9. Consider the following method that is intended to return the sum of the elements in the array `key`.

```
public static int sumArray(int[] key)
{
  int sum = 0;

  for (int i = 1; i <= key.length; i++)
  {
    /* missing code */
  }

  return sum;
}
```

Which of the following statements should be used to replace `/* missing code */` so that `sumArray` will work as intended?

(A) `sum = key[i];`

(B) `sum += key[i - 1];`

(C) `sum += key[i];`

(D) `sum += sum + key[i - 1];`

(E) `sum += sum + key[i];`

Questions 10-11 refer to the following information.

Consider the following instance variable and methods. You may assume that `data` has been initialized with length > 0. The methods are intended to return the index of an array element equal to `target`, or -1 if no such element exists.

```
private int[] data;

public int seqSearchRec(int target)
{
  return seqSearchRecHelper(target, data.length - 1);
}


private int seqSearchRecHelper(int target, int last)
{
  // Line 1

  if (data[last] == target)
    return last;
  else
    return seqSearchRecHelper(target, last - 1);
}
```

10. For which of the following test cases will the call `seqSearchRec(5)` always result in an error?

I. `data` contains only one element.

II. `data` does not contain the value 5.

III. `data` contains the value 5 multiple times.

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I, II, and III

---

11. Which of the following should be used to replace `// Line 1` in `seqSearchRecHelper` so that `seqSearchRec` will work as intended?

(A)
```
if (last <= 0)
  return -1;
```

(B)
```
if (last < 0)
  return -1;
```

(C)
```
if (last < data.length)
  return -1;
```

(D)
```
while (last < data.length)
```

(E)
```
while (last >= 0)
```

12. Consider the following method.

```
public String mystery(String input)
{
  String output = "";

  for (int k = 1; k < input.length(); k = k + 2)
  {
    output += input.substring(k, k + 1);
  }

  return output;
}
```

What is returned as a result of the call `mystery("computer")` ?

(A) `"computer"`

(B) `"cmue"`

(C) `"optr"`

(D) `"ompute"`

(E) Nothing is returned because an `IndexOutOfBoundsException` is thrown.

13. Consider the following code segment.

```
int[] arr = {7, 2, 5, 3, 0, 10};
for (int k = 0; k < arr.length - 1; k++)
{
  if (arr[k] > arr[k + 1])
    System.out.print(k + "  " + arr[k] + "  ");
}
```

What will be printed as a result of executing the code segment?

(A) `0  2  2  3  3  0`

(B) `0  7  2  5  3  3`

(C) `0  7  2  5  5  10`

(D) `1  7  3  5  4  3`

(E) `7  2  5  3  3  0`

14. Consider the following interface and class declarations.

```
public interface Vehicle
{
  /** @return the mileage traveled by this Vehicle
   */
  double getMileage();
}


public class Fleet
{
  private ArrayList<Vehicle> myVehicles;

  /** @return the mileage traveled by all vehicles in this Fleet
   */
  public double getTotalMileage()
  {
    double sum = 0.0;

    for (Vehicle v : myVehicles)
    {
      sum += /* expression */ ;
    }

    return sum;
  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

Which of the following can be used to replace `/* expression */` so that `getTotalMileage` returns the total of the miles traveled for all vehicles in the fleet?

(A) `getMileage(v)`

(B) `myVehicles[v].getMileage()`

(C) `Vehicle.get(v).getMileage()`

(D) `myVehicles.get(v).getMileage()`

(E) `v.getMileage()`

15. Consider the following method, `isSorted`, which is intended to return `true` if an array of integers is sorted in nondecreasing order and to return `false` otherwise.

```
/** @param data an array of integers
 *  @return true if the values in the array appear in sorted (nondecreasing) order
 */
public static boolean isSorted(int[] data)
{
  /* missing code */
}
```

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

I.
```
for (int k = 1; k < data.length; k++)
{
  if (data[k - 1] > data[k])
    return false;
}
return true;
```

II.
```
for (int k = 0; k < data.length; k++)
{
  if (data[k] > data[k + 1])
    return false;
}
return true;
```

III.
```
for (int k = 0; k < data.length - 1; k++)
{
  if (data[k] > data[k + 1])
    return false;
  else
    return true;
}
return true;
```

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I and III only

16. Consider the following incomplete method that is intended to return an array that contains the contents of its first array parameter followed by the contents of its second array parameter.

```
public static int[] append(int[] a1, int[] a2)
{
  int[] result = new int[a1.length + a2.length];

  for (int j = 0; j < a1.length; j++)
    result[j] = a1[j];

  for (int k = 0; k < a2.length; k++)
    result[ /* index */ ] = a2[k];

  return result;
}
```

Which of the following expressions can be used to replace `/* index */` so that `append` will work as intended?

(A) `j`

(B) `k`

(C) `k + a1.length - 1`

(D) `k + a1.length`

(E) `k + a1.length + 1`

17. Consider the following code segment.

```
int[] arr = {1, 2, 3, 4, 5, 6, 7};

for (int k = 3; k < arr.length - 1; k++)
  arr[k] = arr[k + 1];
```

Which of the following represents the contents of `arr` as a result of executing the code segment?

(A) `{1, 2, 3, 4, 5, 6, 7}`

(B) `{1, 2, 3, 5, 6, 7}`

(C) `{1, 2, 3, 5, 6, 7, 7}`

(D) `{1, 2, 3, 5, 6, 7, 8}`

(E) `{2, 3, 4, 5, 6, 7, 7}`

18. Assume that `myList` is an `ArrayList` that has been correctly constructed and populated with objects. Which of the following expressions produces a valid random index for `myList` ?

(A) `(int)( Math.random() * myList.size() ) - 1`

(B) `(int)( Math.random() * myList.size() )`

(C) `(int)( Math.random() * myList.size() ) + 1`

(D) `(int)( Math.random() * (myList.size() + 1) )`

(E) `Math.random(myList.size())`

19. Assume that `a` and `b` have been defined and initialized as `int` values. The expression

```
!(!(a != b ) && (b > 7))
```

is equivalent to which of the following?

(A) `(a != b) || (b < 7)`

(B) `(a != b) || (b <= 7)`

(C) `(a == b) || (b <= 7)`

(D) `(a != b) && (b <= 7)`

(E) `(a == b) && (b > 7)`

20. Consider the following method.

```
public static void arrayMethod(int nums[])
{
  int j = 0;
  int k = nums.length - 1;

  while (j < k)
  {
    int x = nums[j];
    nums[j] = nums[k];
    nums[k] = x;
    j++;
    k--;
  }
}
```

Which of the following describes what the method `arrayMethod()` does to the array `nums`?

(A) The array `nums` is unchanged.

(B) The first value in `nums` is copied to every location in the array.

(C) The last value in `nums` is copied to every location in the array.

(D) The method generates an `ArrayIndexOutOfBoundsException`.

(E) The contents of the array `nums` are reversed.

21. Consider the following method, which is intended to return the element of a 2-dimensional array that is closest in value to a specified number, `val`.

```
/** @return the element of 2-dimensional array mat whose value is closest to val */
public double findClosest(double[][] mat, double val)
{
  double answer = mat[0][0];
  double minDiff = Math.abs(answer - val);
  for (double[] row : mat)
  {
    for (double num : row)
    {
      if ( /* missing code */ )
      {
        answer = num;
        minDiff = Math.abs(num - val);
      }
    }
  }
  return answer;
}
```

Which of the following could be used to replace `/* missing code */` so that `findClosest` will work as intended?

(A) `val - row[num] < minDiff`

(B) `Math.abs(num - minDiff) < minDiff`

(C) `val - num < 0.0`

(D) `Math.abs(num - val) < minDiff`

(E) `Math.abs(row[num] - val) < minDiff`

22. Consider the following `Book` and `AudioBook` classes.

```
public class Book
{
  private int numPages;
  private String bookTitle;

  public Book(int pages, String title)
  {
    numPages = pages;
    bookTitle = title;
  }

  public String toString()
  {
    return bookTitle + " " + numPages;
  }

  public int length()
  {
    return numPages;
  }
}


public class AudioBook extends Book
{
  private int numMinutes;

  public AudioBook(int minutes, int pages, String title)
  {
    super(pages, title);
    numMinutes = minutes;
  }

  public int length()
  {
    return numMinutes;
  }

  public double pagesPerMinute()
  {
    return ((double) super.length()) / numMinutes;
  }
}
```

Consider the following code segment that appears in a class other than `Book` or `AudioBook`.

```
Line 1:  Book[] books = new Book[2];
Line 2:  books[0] = new AudioBook(100, 300, "The Jungle");
Line 3:  books[1] = new Book(400, "Captains Courageous");
Line 4:  System.out.println(books[0].pagesPerMinute());
Line 5:  System.out.println(books[0].toString());
Line 6:  System.out.println(books[0].length());
Line 7:  System.out.println(books[1].toString());
```

Which of the following best explains why the code segment will not compile?

(A) Line 2 will not compile because variables of type `Book` may not refer to variables of type `AudioBook`.

(B) Line 4 will not compile because variables of type `Book` may only call methods in the `Book` class.

(C) Line 5 will not compile because the `AudioBook` class does not have a method named `toString` declared or implemented.

(D) Line 6 will not compile because the statement is ambiguous. The compiler cannot determine which `length` method should be called.

(E) Line 7 will not compile because the element at index 1 in the array named `books` may not have been initialized.

23. Consider the following instance variable and method.

```
private List<String> animals;

public void manipulate()
{
  for (int k = animals.size() - 1; k > 0; k--)
  {
    if (animals.get(k).substring(0, 1).equals("b"))
    {
      animals.add(animals.size() - k, animals.remove(k));
    }
  }
}
```

Assume that `animals` has been instantiated and initialized with the following contents.

```
["bear", "zebra", "bass", "cat", "koala", "baboon"]
```

What will the contents of `animals` be as a result of calling `manipulate` ?

(A) `["baboon", "zebra", "bass", "cat", "bear", "koala"]`

(B) `["bear", "zebra", "bass", "cat", "koala", "baboon"]`

(C) `["baboon", "bear", "zebra", "bass", "cat", "koala"]`

(D) `["bear", "baboon", "zebra", "bass", "cat", "koala"]`

(E) `["zebra", "cat", "koala", "baboon", "bass", "bear"]`

24. Consider the following code segment.

```
int[] oldArray = {1, 2, 3, 4, 5, 6, 7, 8, 9};
int[][] newArray = new int[3][3];

int row = 0;
int col = 0;
for (int value : oldArray)
{
  newArray[row][col] = value;
  row++;
  if ((row % 3) == 0)
  {
    col++;
    row = 0;
  }
}

System.out.println(newArray[0][2]);
```

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

(A) 3

(B) 4

(C) 5

(D) 7

(E) 8

25. A rectangular box fits inside another rectangular box if and only if the height, width, and depth of the smaller box are each less than the corresponding values of the larger box. Consider the following three interface declarations that are intended to represent information necessary for rectangular boxes.

I.
```
public interface RBox
{
  /** @return the height of this RBox */
  double getHeight();

  /** @return the width of this RBox */
  double getWidth();

  /** @return the depth of this RBox */
  double getDepth();
}
```

II.
```
public interface RBox
{
  /** @return true if the height of this RBox is less than the height of other;
   *          false otherwise
   */
  boolean smallerHeight(RBox other);

  /** @return true if the width of this RBox is less than the width of other;
   *          false otherwise
   */
  boolean smallerWidth(RBox other);

  /** @return true if the depth of this RBox is less than the depth of other;
   *          false otherwise
   */
  boolean smallerDepth(RBox other);
}
```

III.
```
public interface RBox
{
  /** @return the surface area of this RBox */
  double getSurfaceArea();

  /** @return the volume of this RBox */
  double getVolume();
}
```

Which of the interfaces, if correctly implemented by a `Box` class, would be sufficient functionality for a user of the `Box` class to determine if one `Box` can fit inside another?

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I, II, and III

26. Assume that the array `arr` has been defined and initialized as follows.

```
int[] arr = /* initial values for the array */ ;
```

Which of the following will correctly print all of the odd integers contained in `arr` but none of the even integers contained in `arr` ?

(A)
```
for (int x : arr)
  if (x % 2 != 0)
    System.out.println(x);
```

(B)
```
for (int k = 1; k < arr.length; k++)
  if (arr[k] % 2 != 0)
    System.out.println(arr[k]);
```

(C)
```
for (int x : arr)
  if (x % 2 != 0)
    System.out.println(arr[x]);
```

(D)
```
for (int k = 0; k < arr.length; k++)
  if (arr[k] % 2 != 0)
    System.out.println(k);
```

(E)
```
for (int x : arr)
  if (arr[x] % 2 != 0)
    System.out.println(arr[x]);
```

Questions 27-28 refer to the following method.

```
public static int mystery(int n)
{
  int x = 1;
  int y = 1;

  // Point A

  while (n > 2)
  {
    x = x + y;

    // Point B

    y = x - y;
    n--;
  }

  // Point C

  return x;
}
```

27. What value is returned as a result of the call `mystery(6)` ?

(A) 1

(B) 5

(C) 6

(D) 8

(E) 13

---

28. Which of the following is true of method `mystery` ?

(A) `x` will sometimes be `1` at `// Point B`.

(B) `x` will never be `1` at `// Point C`.

(C) `n` will never be greater than `2` at `// Point A`.

(D) `n` will sometimes be greater than `2` at `// Point C`.

(E) `n` will always be greater than `2` at `// Point B`.

29. Consider the following code segment.

```
for (int k = 1; k <= 100; k++)
  if ((k % 4) == 0)
    System.out.println(k);
```

Which of the following code segments will produce the same output as the code segment above?

(A)
```
for (int k = 1; k <= 25; k++)
  System.out.println(k);
```

(B)
```
for (int k = 1; k <= 100; k = k + 4)
  System.out.println(k);
```

(C)
```
for (int k = 1; k <= 100; k++)
  System.out.println(k % 4);
```

(D)
```
for (int k = 4; k <= 25; k = 4 * k)
  System.out.println(k);
```

(E)
```
for (int k = 4; k <= 100; k = k + 4)
  System.out.println(k);
```

30. Consider the following method.

```
public static String scramble(String word, int howFar)
{
  return word.substring(howFar + 1, word.length()) +
         word.substring(0, howFar);
}
```

What value is returned as a result of the call `scramble("compiler", 3)`?

(A) `"compiler"`

(B) `"pilercom"`

(C) `"ilercom"`

(D) `"ilercomp"`

(E) No value is returned because an `IndexOutOfBoundsException` will be thrown.

31. Consider the following method.

```
public void mystery(int[] data)
{
  for (int k = 0; k < data.length - 1; k++)
    data[k + 1] = data[k] + data[k + 1];
}
```

The following code segment appears in another method in the same class.

```
int[] values = {5, 2, 1, 3, 8};
mystery(values);
for (int v : values)
  System.out.print(v + " ");
System.out.println();
```

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

(A) `5 2 1 3 8`

(B) `5 7 3 4 11`

(C) `5 7 8 11 19`

(D) `7 3 4 11 8`

(E) Nothing is printed because an `ArrayIndexOutOfBoundsException` is thrown during the execution of method `mystery`.

32. Consider the following method.

```
public int compute(int n, int k)
{
  int answer = 1;

  for (int i = 1; i <= k; i++)
    answer *= n;

  return answer;
}
```

Which of the following represents the value returned as a result of the call `compute(n, k)` ?

(A) $n*k$

(B) $n!$

(C) n^k

(D) 2^k

(E) k^n

33. Consider the following code segment.

```
int sum = 0;
int k = 1;
while (sum < 12 || k < 4)
  sum += k;

System.out.println(sum);
```

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

(A) 6

(B) 10

(C) 12

(D) 15

(E) Nothing is printed due to an infinite loop.

34. Consider the following class declarations.

```
public class Point
{
  private double x;  // x-coordinate
  private double y;  // y-coordinate

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

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

  // There may be instance variables, constructors, and methods that are not shown.
}


public class Circle
{
  private Point center;
  private double radius;

  /** Constructs a circle where (a, b) is the center and r is the radius.
   */
  public Circle(double a, double b, double r)
  {
    /* missing code */
  }
}
```

Which of the following replacements for `/* missing code */` will correctly implement the `Circle` constructor?

I.
```
center = new Point();
radius = r;
```

II.
```
center = new Point(a, b);
radius = r;
```

III.
```
center = new Point();
center.x = a;
center.y = b;
radius = r;
```

(A) I only

(B) II only

(C) III only

(D) II and III only

(E) I, II, and III

35. Consider the following code segment.

```
int num = 2574;
int result = 0;

while (num > 0)
{
  result = result * 10 + num % 10;
  num /= 10;
}
System.out.println(result);
```

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

(A) 2

(B) 4

(C) 18

(D) 2574

(E) 4752

36. Consider the following method.

```
public void test(int x)
{
  int y;

  if (x % 2 == 0)
    y = 3;
  else if (x > 9)
    y = 5;
  else
    y = 1;

  System.out.println("y = " + y);
}
```

Which of the following test data sets would test each possible output for the method?

(A) 8, 9, 12

(B) 7, 9, 11

(C) 8, 9, 11

(D) 8, 11, 13

(E) 7, 9, 10

37. Consider the following code segment.

```
int x = 1;
while ( /* missing code */ )
{
  System.out.print(x + " ");
  x = x + 2;
}
```

Consider the following possible replacements for `/* missing code */`.

I. `x < 6`

II. `x != 6`

III. `x < 7`

Which of the proposed replacements for `/* missing code */` will cause the code segment to print only the values `1 3 5` ?

(A) I only

(B) II only

(C) I and II only

(D) I and III only

(E) I, II, and III

38. Assume that `x` and `y` have been declared and initialized with `int` values. Consider the following Java expression.

```
(y > 10000) || (x > 1000 && x < 1500)
```

Which of the following is equivalent to the expression given above?

(A) `(y > 10000 || x > 1000) && (y > 10000 || x < 1500)`

(B) `(y > 10000 || x > 1000) || (y > 10000 || x < 1500)`

(C) `(y > 10000) && (x > 1000 || x < 1500)`

(D) `(y > 10000 && x > 1000) || (y > 10000 && x < 1500)`

(E) `(y > 10000 && x > 1000) && (y > 10000 && x < 1500)`

39. Consider the following recursive method.

```
public int recur(int n)
{
  if (n <= 10)
    return n * 2;
  else
    return recur(recur(n / 3));
}
```

What value is returned as a result of the call `recur(27)` ?

(A) 8

(B) 9

(C) 12

(D) 16

(E) 18

40. Consider the following recursive method.

```
public static void whatsItDo(String str)
{
  int len = str.length();
  if (len > 1)
  {
    String temp = str.substring(0, len - 1);
    whatsItDo(temp);
    System.out.println(temp);
  }
}
```

What is printed as a result of the call `whatsItDo("WATCH")` ?

(A)
```
WATC
WAT
WA
W
```

(B)
```
WATCH
WATC
WAT
WA
```

(C)
```
W
WA
WAT
WATC
```

(D)
```
W
WA
WAT
WATC
WATCH
```

(E)
```
WATCH
WATC
WAT
WA
W
WA
WAT
WATC
WATCH
```

END OF SECTION I

IF YOU FINISH BEFORE TIME IS CALLED,
YOU MAY CHECK YOUR WORK ON THIS SECTION.

DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.

Java Quick Reference

Accessible Methods from the Java Library That May Be Included on the Exam

class java.lang.Object

- `boolean equals(Object other)`
- `String toString()`

class java.lang.Integer

- `Integer(int value)`
- `int intValue()`
- `Integer.MIN_VALUE` // minimum value represented by an `int` or `Integer`
- `Integer.MAX_VALUE` // maximum value represented by an `int` or `Integer`

class java.lang.Double

- `Double(double value)`
- `double doubleValue()`

class java.lang.String

- `int length()`
- `String substring(int from, int to)` // returns the substring beginning at `from`
  // and ending at `to-1`
- `String substring(int from)` // returns `substring(from, length())`
- `int indexOf(String str)` // returns the index of the first occurrence of `str`;
  // returns `-1` if not found
- `int compareTo(String other)` // returns a value < 0 if `this` is less than `other`
  // returns a value = 0 if `this` is equal to `other`
  // returns a value > 0 if `this` is greater than `other`

class java.lang.Math

- `static int abs(int x)`
- `static double abs(double x)`
- `static double pow(double base, double exponent)`
- `static double sqrt(double x)`
- `static double random()` // returns a `double` in the range [0.0, 1.0)

interface java.util.List<E>

- `int size()`
- `boolean add(E obj)` // appends `obj` to end of list; returns `true`
- `void add(int index, E obj)` // inserts `obj` at position `index` (0 ≤ `index` ≤ size),
  // moving elements at position `index` and higher
  // to the right (adds 1 to their indices) and adjusts size
- `E get(int index)`
- `E set(int index, E obj)` // replaces the element at position `index` with `obj`
  // returns the element formerly at the specified position
- `E remove(int index)` // removes element from position `index`, moving elements
  // at position `index + 1` and higher to the left
  // (subtracts 1 from their indices) and adjusts size
  // returns the element formerly at the specified position

class java.util.ArrayList<E> implements java.util.List<E>

Section II

Free-Response Questions

COMPUTER SCIENCE A

SECTION II

Time—1 hour and 30 minutes

Number of questions—4

Percent of total grade—50

Directions: SHOW ALL YOUR WORK. REMEMBER THAT PROGRAM SEGMENTS ARE TO BE WRITTEN IN JAVA.

Notes:

- Assume that the classes listed in the Java Quick Reference have been imported where appropriate.
- Unless otherwise noted in the question, assume that parameters in method calls are not `null` and that methods are called only when their preconditions are satisfied.
- In writing solutions for each question, you may use any of the accessible methods that are listed in classes defined in that question. Writing significant amounts of code that can be replaced by a call to one of these methods will not receive full credit.

1. Consider the following partial declaration for a `WordScrambler` class. The constructor for the `WordScrambler` class takes an even-length array of `String` objects and initializes the instance variable `scrambledWords`.

```
public class WordScrambler
{
  private String[] scrambledWords;

  /** @param wordArr an array of String objects
   *          Precondition: wordArr.length is even
   */
  public WordScrambler(String[] wordArr)
  {
    scrambledWords = mixedWords(wordArr);
  }


  /** @param word1 a String of characters
   *  @param word2 a String of characters
   *  @return a String that contains the first half of word1 and the second half of word2
   */
  private String recombine(String word1, String word2)
  {  /* to be implemented in part (a) */  }


  /** @param words an array of String objects
   *          Precondition: words.length is even
   *  @return an array of String objects created by recombining pairs of strings in array words
   *  Postcondition: the length of the returned array is words.length
   */
  private String[] mixedWords(String[] words)
  {  /* to be implemented in part (b) */  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

GO ON TO THE NEXT PAGE.

(a) Write the `WordScrambler` method `recombine`. This method returns a `String` created from its two `String` parameters as follows.

- take the first half of `word1`
- take the second half of `word2`
- concatenate the two halves and return the new string.

For example, the following table shows some results of calling `recombine`. Note that if a word has an odd number of letters, the second half of the word contains the extra letter.

`word1`	`word2`	`recombine(word1, word2)`
`"apple"`	`"pear"`	`"apar"`
`"pear"`	`"apple"`	`"peple"`

Complete method `recombine` below.

```
/** @param word1 a String of characters
 *  @param word2 a String of characters
 *  @return a String that contains the first half of word1 and the second half of word2
 */
private String recombine(String word1, String word2)
```

(b) Write the `WordScrambler` method `mixedWords`. This method creates and returns a new array of `String` objects as follows.

It takes the first pair of strings in `words` and combines them to produce a pair of strings to be included in the array returned by the method. If this pair of strings consists of `w1` and `w2`, the method should include the result of calling `recombine` with `w1` and `w2` as arguments and should also include the result of calling `recombine` with `w2` and `w1` as arguments. The next two strings, if they exist, would form the next pair to be processed by this method. The method should continue until all the strings in `words` have been processed in this way and the new array has been filled. For example, if the array `words` contains the following elements:

```
{"apple", "pear", "this", "cat"}
```

then the call `mixedWords(words)` should return the following array.

```
{"apar", "peple", "that", "cis"}
```

In writing `mixedWords`, you may call `recombine`. Assume that `recombine` works as specified, regardless of what you wrote in part (a).

Complete method `mixedWords` below.

```
/** @param words an array of String objects
 *          Precondition: words.length is even
 *  @return an array of String objects created by recombining pairs of strings in array words
 *  Postcondition: the length of the returned array is words.length
 */
private String[] mixedWords(String[] words)
```

GO ON TO THE NEXT PAGE.

2. An array of positive integer values has the *mountain* property if the elements are ordered such that successive values increase until a maximum value (the peak of the mountain) is reached and then the successive values decrease. The `Mountain` class declaration shown below contains methods that can be used to determine if an array has the mountain property. You will implement two methods in the `Mountain` class.

```
public class Mountain
{
  /** @param array an array of positive integer values
   *  @param stop the last index to check
   *          Precondition: 0 ≤ stop < array.length
   *  @return true if for each j such that 0 ≤ j < stop, array[j] < array[j + 1] ;
   *          false otherwise
   */
  public static boolean isIncreasing(int[] array, int stop)
  {  /*  implementation not shown  */  }


  /** @param array an array of positive integer values
   *  @param start the first index to check
   *        Precondition: 0 ≤ start < array.length - 1
   *  @return true if for each j such that start ≤ j < array.length - 1,
   *                array[j] > array[j + 1];
   *          false otherwise
   */
  public static boolean isDecreasing(int[] array, int start)
  {  /*  implementation not shown  */  }


  /** @param array an array of positive integer values
   *          Precondition: array.length > 0
   *  @return the index of the first peak (local maximum) in the array, if it exists;
   *          -1 otherwise
   */
  public static int getPeakIndex(int[] array)
  {  /*  to be implemented in part (a)  */  }


  /** @param array an array of positive integer values
   *          Precondition: array.length > 0
   *  @return true if array contains values ordered as a mountain;
   *          false otherwise
   */
  public static boolean isMountain(int[] array)
  {  /*  to be implemented in part (b)  */  }

  // There may be instance variables, constructors, and methods that are not shown.

}
```

(a) Write the `Mountain` method `getPeakIndex`. Method `getPeakIndex` returns the index of the first peak found in the parameter `array`, if one exists. A peak is defined as an element whose value is greater than the value of the element immediately before it and is also greater than the value of the element immediately after it. Method `getPeakIndex` starts at the beginning of the array and returns the index of the first peak that is found or -1 if no peak is found.

For example, the following table illustrates the results of several calls to `getPeakIndex`.

arr	getPeakIndex(arr)
{11, 22, 33, 22, 11}	2
{11, 22, 11, 22, 11}	1
{11, 22, 33, 55, 77}	-1
{99, 33, 55, 77, 120}	-1
{99, 33, 55, 77, 55}	3
{33, 22, 11}	-1

Complete method `getPeakIndex` below.

```
/** @param array an array of positive integer values
 *          Precondition: array.length > 0
 *  @return the index of the first peak (local maximum) in the array, if it exists;
 *           -1 otherwise
 */
public static int getPeakIndex(int[] array)
```

(b) Write the `Mountain` method `isMountain`. Method `isMountain` returns `true` if the values in the parameter `array` are ordered as a mountain; otherwise, it returns `false`. The values in `array` are ordered as a mountain if all three of the following conditions hold.

- There must be a peak.
- The array elements with an index smaller than the peak's index must appear in increasing order.
- The array elements with an index larger than the peak's index must appear in decreasing order.

For example, the following table illustrates the results of several calls to `isMountain`.

arr	isMountain(arr)
{1, 2, 3, 2, 1}	true
{1, 2, 1, 2, 1}	false
{1, 2, 3, 1, 5}	false
{1, 4, 2, 1, 0}	true
{9, 3, 5, 7, 5}	false
{3, 2, 1}	false

In writing `isMountain`, assume that `getPeakIndex` works as specified, regardless of what you wrote in part (a).

Complete method `isMountain` below.

```
/** @param array an array of positive integer values
 *          Precondition: array.length > 0
 *  @return true if array contains values ordered as a mountain;
 *          false otherwise
 */
public static boolean isMountain(int[] array)
```

3. A two-dimensional array of temperatures is represented in the following class.

```
public class TemperatureGrid
{
  /** A two-dimensional array of temperature values, initialized in the constructor (not shown)
   *  Guaranteed not to be null
   */
  private double[][] temps;

  /** Computes and returns a new temperature value for the given location.
   *  @param row a valid row index in temps
   *  @param col a valid column index in temps
   *  @return the new temperature for temps[row][col]
   *          - The new temperature for any element in the border of the array is the
   *            same as the old temperature.
   *          - Otherwise, the new temperature is the average of the four adjacent entries.
   *  Postcondition: temps is unchanged.
   */
  private double computeTemp(int row, int col)
  {  /* to be implemented in part (a) */  }


  /** Updates all values in temps and returns a boolean that indicates whether or not all the
   *  new values were within tolerance of the original values.
   *  @param tolerance a double value >= 0
   *  @return true if all updated temperatures are within tolerance of the original values;
   *          false otherwise.
   *  Postcondition: Each value in temps has been updated with a new value based on the
   *                 corresponding call to computeTemp.
   */
  public boolean updateAllTemps(double tolerance)
  {  /* to be implemented in part (b) */  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

GO ON TO THE NEXT PAGE.

(a) Write method `computeTemp`, which computes and returns the new temperature for a given element of `temps` according to the following rules.

1. If the element is in the border of the array (in the first row or last row or first column or last column), the new temperature is the same as the old temperature.

2. Otherwise, the new temperature is the average (arithmetic mean) of the temperatures of the four adjacent values in the table (located above, below, to the left, and to the right of the element).

If `temps` is the table shown below, `temps.length` is `5` and `temps[0].length` is `6`.

	0	**1**	**2**	**3**	**4**	**5**
0	95.5	100.0	100.0	100.0	100.0	110.3
1	0.0	50.0	50.0	50.0	50.0	0.0
2	0.0	40.0	40.0	40.0	40.0	0.0
3	0.0	20.0	20.0	20.0	20.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0

The following table shows the results of several calls to `computeTemp`.

Function Call	Result
`computeTemp(2, 3)`	`37.5` (the average of the values 50.0, 20.0, 40.0, and 40.0)
`computeTemp(1, 1)`	`47.5` (the average of the values 100.0, 40.0, 0.0, and 50.0)
`computeTemp(0, 2)`	`100.0` (the same as the old value)
`computeTemp(1, 3)`	`60.0` (the average of the values 100.0, 40.0, 50.0, and 50.0)

Complete method `computeTemp` below.

```
/** Computes and returns a new temperature value for the given location.
 *  @param row a valid row index in temps
 *  @param col a valid column index in temps
 *  @return the new temperature for temps[row][col]
 *          - The new temperature for any element in the border of the array is the
 *            same as the old temperature.
 *          - Otherwise, the new temperature is the average of the four adjacent entries.
 *  Postcondition: temps is unchanged.
 */
private double computeTemp(int row, int col)
```

(b) Write method `updateAllTemps`, which computes the new temperature for every element of `temps`. The new values should be based on the original values, so it will be necessary to create another two-dimensional array in which to store the new values. Once all the computations are complete, the new values should replace the corresponding positions of `temps`. Method `updateAllTemps` also determines whether every new temperature is within `tolerance` of the corresponding old temperature (i.e., the absolute value of the difference between the old temperature and the new temperature is less than or equal to `tolerance`). If so, it returns `true`; otherwise, it returns `false`.

If `temps` contains the values shown in the first table below, then the call `updateAllTemps(0.01)` should update `temps` as shown in the second table.

`temps` before the call `updateAllTemps(0.01)`

	0	1	2	3	4	5
0	95.5	100.0	100.0	100.0	100.0	110.3
1	0.0	50.0	50.0	50.0	50.0	0.0
2	0.0	40.0	40.0	40.0	40.0	0.0
3	0.0	20.0	20.0	20.0	20.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0

`temps` after the call `updateAllTemps(0.01)`

	0	1	2	3	4	5
0	95.5	100.0	100.0	100.0	100.0	110.3
1	0.0	47.5	60.0	60.0	47.5	0.0
2	0.0	27.5	37.5	37.5	27.5	0.0
3	0.0	15.0	20.0	20.0	15.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0

In the example shown, the call `updateAllTemps(0.01)` should return `false` because there are several new temperatures that are not within the given tolerance of the corresponding old temperature. For example, the updated value in `temps[2][3]` is `37.5`, the original value in `temps[2][3]` was `40.0`, and the absolute value of `(37.5 - 40.0)` is greater than the value of `tolerance` (`0.01`).

Assume that `computeTemp` works as specified, regardless of what you wrote in part (a).

Complete method `updateAllTemps` below.

```
/** Updates all values in temps and returns a boolean that indicates whether or not all the
 *  new values were within tolerance of the original values.
 *  @param tolerance a double value >= 0
 *  @return true if all updated temperatures are within tolerance of the original values;
 *          false otherwise.
 *  Postcondition: Each value in temps has been updated with a new value based on the
 *                 corresponding call to computeTemp.
 */
public boolean updateAllTemps(double tolerance)
```

4. A school district would like to get some statistics on its students' standardized test scores. Scores will be represented as objects of the following `ScoreInfo` class. Each `ScoreInfo` object contains a score value and the number of students who earned that score.

```
public class ScoreInfo
{
  private int score;
  private int numStudents;

  public ScoreInfo(int aScore)
  {
    score = aScore;
    numStudents = 1;
  }

  /** adds 1 to the number of students who earned this score
   */
  public void increment()
  {  numStudents++;  }

  /** @return this score
   */
  public int getScore()
  {  return score;  }

  /** @return the number of students who earned this score
   */
  public int getFrequency()
  {  return numStudents;  }
}
```

The following `Stats` class creates and maintains a database of student score information. The scores are stored in sorted order in the database.

```
public class Stats
{
  private ArrayList<ScoreInfo> scoreList;
    // listed in increasing score order; no two ScoreInfo objects contain the same score

  /** Records a score in the database, keeping the database in increasing score order. If no other
   *  ScoreInfo object represents score, a new ScoreInfo object representing score
   *  is added to the database; otherwise, the frequency in the ScoreInfo object representing
   *  score is incremented.
   *  @param score a score to be recorded in the list
   *  @return true if a new ScoreInfo object representing score was added to the list;
   *          false otherwise
   */
  public boolean record(int score)
  { /*  to be implemented in part (a)  */}

  /** Records all scores in stuScores in the database, keeping the database in increasing score order
   *  @param stuScores an array of student test scores
   */
  public void recordScores(int[] stuScores)
  {  /*  to be implemented in part (b)  */  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

(a) Write the `Stats` method `record` that takes a test score and records that score in the database. If the score already exists in the database, the frequency of that score is updated. If the score does not exist in the database, a new `ScoreInfo` object is created and inserted in the appropriate position so that the database is maintained in increasing score order. The method returns `true` if a new `ScoreInfo` object was added to the database; otherwise, it returns `false`.

Complete method `record` below.

```
/** Records a score in the database, keeping the database in increasing score order. If no other
 *  ScoreInfo object represents score, a new ScoreInfo object representing score
 *  is added to the database; otherwise, the frequency in the ScoreInfo object representing
 *  score is incremented.
 *  @param score a score to be recorded in the list
 *  @return true if a new ScoreInfo object representing score was added to the list;
 *          false otherwise
 */
public boolean record(int score)
```

(b) Write the `Stats` method `recordScores` that takes an array of test scores and records them in the database. The database contains at most one `ScoreInfo` object per unique score value. Each `ScoreInfo` object contains a score and an associated frequency. The database is maintained in increasing order based on the score.

In writing `recordScores`, assume that `record` works as specified, regardless of what you wrote in part (a).

Complete method `recordScores` below.

```
/** Records all scores in stuScores in the database, keeping the database in increasing score order
 *  @param stuScores an array of student test scores
 */
public void recordScores(int[] stuScores)
```

STOP

END OF EXAM

Java Quick Reference

Accessible Methods from the Java Library That May Be Included on the Exam

class java.lang.Object

- `boolean equals(Object other)`
- `String toString()`

class java.lang.Integer

- `Integer(int value)`
- `int intValue()`
- `Integer.MIN_VALUE` // minimum value represented by an `int` or `Integer`
- `Integer.MAX_VALUE` // maximum value represented by an `int` or `Integer`

class java.lang.Double

- `Double(double value)`
- `double doubleValue()`

class java.lang.String

- `int length()`
- `String substring(int from, int to)` // returns the substring beginning at `from`
  // and ending at `to-1`
- `String substring(int from)` // returns `substring(from, length())`
- `int indexOf(String str)` // returns the index of the first occurrence of `str`;
  // returns `-1` if not found
- `int compareTo(String other)` // returns a value < 0 if `this` is less than `other`
  // returns a value = 0 if `this` is equal to `other`
  // returns a value > 0 if `this` is greater than `other`

class java.lang.Math

- `static int abs(int x)`
- `static double abs(double x)`
- `static double pow(double base, double exponent)`
- `static double sqrt(double x)`
- `static double random()` // returns a `double` in the range [0.0, 1.0)

interface java.util.List<E>

- `int size()`
- `boolean add(E obj)` // appends `obj` to end of list; returns `true`
- `void add(int index, E obj)` // inserts `obj` at position `index` (0 ≤ `index` ≤ size),
  // moving elements at position `index` and higher
  // to the right (adds 1 to their indices) and adjusts size
- `E get(int index)`
- `E set(int index, E obj)` // replaces the element at position `index` with `obj`
  // returns the element formerly at the specified position
- `E remove(int index)` // removes element from position `index`, moving elements
  // at position `index + 1` and higher to the left
  // (subtracts 1 from their indices) and adjusts size
  // returns the element formerly at the specified position

class java.util.ArrayList<E> implements java.util.List<E>