COMPUTER SCIENCE A

SECTION I

Time—1 hour and 30 minutes

Number of Questions—40

Percent of total exam grade—50%

Directions: Determine the answer to each of the following questions or incomplete statements, using the available space for any necessary scratchwork. Then decide which is the best of the choices given and fill in the corresponding oval on the 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 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 the method calls are not `null` and that methods are called only when their preconditions are satisfied.

1. Consider the following methods.

```
public void trial()
{
        int a = 10;
        int b = 5;
        doubleValues(a, b);
        System.out.print(b);
        System.out.print(a);
}

public void doubleValues(int c, int d)
{
        c = c * 2;
        d = d * 2;
        System.out.print(c);
        System.out.print(d);
}
```

What is printed as the result of the call `trial()`?

(A) `2010`
(B) `2010105`
(C) `2010510`
(D) `20102010`
(E) `20101020`

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2. Consider the following method.

```
/**
 * Precondition: a > b > 0
 */
public static int mystery(int a, int b)
{
   int d = 0;
   for (int c = a; c > b; c--)
   {
      d = d + c;
   }
   return d;
}
```

What is returned by the call `mystery(x, y)`?

(A) The sum of all integers greater than `y` but less than or equal to `x`
(B) The sum of all integers greater than or equal to `y` but less than or equal to `x`
(C) The sum of all integers greater than `y` but less than `x`
(D) The sum of all integers greater than or equal to `y` but less than `x`
(E) The sum of all integers less than `y` but greater than or equal to `x`

3. Consider the following method.

```
public void mystery (int  n)
{
   int k;
   for (k = 0 ; k < n ; k++)
   {
      mystery(k);
      System.out.print (k);
   }
}
```

What is printed by the call `mystery(3)` ?

(A) `0123`
(B) `00123`
(C) `0010012`
(D) `00100123`
(E) `001001200100123`

4. Consider an array of integers.

4	10	1	2	6	7	3	5

If selection sort is used to order the array from smallest to largest values, which of the following represents a possible state of the array at some point during the selection sort process?

(A) 1 4 10 2 3 6 7 5
(B) 1 2 4 6 10 7 3 5
(C) 1 2 3 10 6 7 4 5
(D) 4 3 1 2 6 7 10 5
(E) 5 3 7 6 2 1 10 4

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5. Consider the following code segment:

```
int  k;
int  a[];
a = new int [7];
for (k = 0; k < a.length; k++)
{
   a[k] = a.length - k;
}
for (k = 0; k < a.length - 1; k++)
{
   a[k+1] = a[k];
}
```

What values will A contain after the code segment is executed?

(A) 1 1 2 3 4 5 6
(B) 1 2 3 4 5 6 7
(C) 6 6 5 4 3 2 1
(D) 7 7 6 5 4 3 2
(E) 7 7 7 7 7 7 7

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Questions 6–7 refer to the following two classes.

```
public class PostOffice
{
    // constructor initializes boxes
    // to length 100
    public PostOffice()
    {   /* implementation not shown   */}

    // returns the P.O. Box based on the given P.O. Box number
    // 0 <= theBox < getNumBoxes ()
    public Box getBox(int theBox)
    {   /* implementation not shown   */}
    // returns the number of p.o. boxes
    public int getNumBoxes()
    {   /* implementation not shown   */}

    // private data members and
    // other methods not shown
}

public class Box
{
    // constructor
    public Box()
    {   /* implementation not shown  */}

    // returns the number of this box
    public int getBoxNumber()
    {   /* implementation not shown   */}

    // returns the number of pieces
    // of mail in this box
    public int getMailCount()
    {   /* implementation not shown  */}
    // returns the given piece of mail
    // 0 <= thePiece < getMailCount ( )
    public Mail getMail(int thePiece)
    {   /* implementation not shown  */}
    // true if the box has been assigned
    // to a customer
    public boolean isAssigned()
    {   /* implementation not shown  */}
    // true if the box contains mail
    public boolean hasMail()
    {   /* implementation not shown  */}
    // private data members and
    // other methods not shown
}
public class Mail
{
    // private members, constructors, and
    // other methods not shown
}
```

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6. Consider the following code segment:

```
PostOffice p[ ];
p = new PostOffice[10];
```

Assuming that the box has been assigned and that it has at least four pieces of mail waiting in it, what is the correct way of getting the fourth piece of mail from the 57th box of the 10th post office of `p`?

(A) `Mail m = p[10].getBox(57).getmail(4);`
(B) `Mail m = p[9].getBox(56).getMail(3);`
(C) `Mail m = p.getMail(57).getMail(4) [10];`
(D) `Mail m = getMail(getBox(p[9], 560, 3);`
(E) `Mail m = new Mail(10, 57, 4);`

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7. Consider the incomplete function `printEmptyBoxes` given below. `printEmptyBoxes` should print the box numbers of all of the boxes that have been assigned to a customer but do not contain mail.

```
public void printEmptyBoxes (PostOffice[] p)
{
   for (int k = 0; k < p.length - 1 ; k++)
   {
      for (int x = 0; x < p[k].getNumBoxes() - 1 ; x++)
      {
           /* missing code */
      }
   }
}
```

Which of the following could be used to replace */* missing code */* so that `printBoxesWithoutMail` works as intended?

(A)
```
if (p[k].getBox(x).isAssigned() &&
!p[k].getBox(x).hasMail())
{
     System.out.println(p[k].getBox(x).getBoxNumber()) ;
}
```

(B)
```
if (p[x].getBox(k).isAssigned() &&
!p[x].getBox(k).hasMail())
{
  System.out.println(p[x].getBox(k).getBoxNumber());
}
```

(C)
```
if (p[k].getBox(x).isAssigned() &&
!p[k].getBox(x).hasMail())
{
     System.out.println (p[k].getBoxNumber (x));
}
```

(D)
```
if (p[x].getBox(k).isAssigned() &&
!p[x].getBox (k).hasMail())
{
     System.out.println(p[x].getBoxNumber(k));
  }
```

(E)
```
if (p[x].getBox(k).isAssigned() &&
p[x].getBox(k).getMail() == 0)
{
     System.out.println(k);
}
```

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8. Assume that a and b are boolean variables that have been initialized. Consider the following code segment.

```
a = a && b;
b = a || b;
```

Which of the following statements is always true?

I. The final value of a is the same as the initial value of a.
II. The final value of b is the same as the initial value of b.
III. The final value of a is the same as the initial value of b.

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

9. Consider the following code segment.

```
int x;
x = 53;
if (x > 10)
{
   System.out.print("A");
}
if (x > 30)
{
   System.out.print("B");
}
else if (x > 40)
{
   System.out.print("C");
}
if (x > 50)
{
   System.out.print ("D");
}
if (x > 70)
{
   System.out.print ("E");
}
```

What is the output when the code is executed?

(A) A
(B) D
(C) ABD
(D) ABCD
(E) ABCDE

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10. Consider the following code segment:

```
int j;
int k;
for (j = -2; j <= 2; j = j + 2)
{
   for (k = j; k < j + 3; k++)
   {
      System.out.print(k + " ");
   }
}
```

What is the output when the code is executed?

(A) -2 -1 0
(B) -2 -1 0 1 2
(C) 0 1 2 0 1 2 0 1 2
(D) -2 0 2
(E) -2 -1 0 0 1 2 2 3 4

11. Consider the following method.

```
public void mystery (int  count, String s)
{
   if  (count  <=  0)
   {
      return;
   }
   if  (count % 3 == 0)
   {
      System.out.print(s + "--" + s);
   }
   else if (count % 3 == 1)
   {
      System.out.print(s + "-" + s);
   }
   else
   {
      System.out.print(s);
   }
   mystery(count - 1, s);
}
```

What is outputted by the call `mystery(5, "X")`?

(A) XX-XX--XXX-X
(B) XX-XX-XX-XX
(C) XXX--XX-X-XX--XXX
(D) XX-XXX--XXX-XX
(E) XXXXX

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Questions 12–13 refer to the following classes and method descriptions.

Class `Table` has a method, `getPrice`, which takes no parameters and returns the price of the table.

Class `Chair` also has a method, `getPrice`, which takes no parameters and returns the price of the chair.

Class `DiningRoomSet` has a constructor which is passed a `Table` object and an `ArrayList` of `Chair` objects. It stores these parameters in its private data fields `myTable` and `myChairs`.

Class `DiningRoomSet` has a method, `getPrice`, which takes no parameters and returns the price of the dining room set. The price of a dining room set is calculated as the sum of the price of its table and all of its chairs.

12. What is the correct way to define the signature of the constructor for the `DiningRoomSet` class?

(A) `public void DiningRoomSet(Table t, ArrayList, chairs)`
(B) `public DiningRoomSet(Table t, ArrayList<Chair> chairs)`
(C) `public void DiningRoomSet(Table t, ArrayList Chair Chairs)`
(D) `public DiningRoomSet(Table t, ArrayList Chair Chairs)`
(E) `public DiningRoomSet(Table t, Chair Chairs)`

13. What is the correct way to implement the getPrice method of the `DiningRoomSet` class?

(A)
```
public double getPrice(Table t, ArrayList chairs)
{
    return t.getPrice() + chairs.getPrice();
}
```

(B)
```
public double getPrice(Table t, ArrayList chairs)
{
    return myTable.getPrice() + myChairs.getPrice();
}
```

(C)
```
public double getPrice()
{
    return myTable.getPrice() + myChairs.getPrice();
}
```

(D)
```
public double getPrice()
{
    double result  = myTable.getPrice();
    for (int k = 0; k < myChairs.size() - 1; k++)
    {
        result += ((Chair)myChairs.get(k)).getPrice();
    }
    return result;
}
```

(E)
```
public double getPrice()
{
    double result = myTable.getPrice();
    for (int k = 0; k  <  myChairs.length - 1; k++)
    {
        result += ((Chair)myChairs[k]).getPrice();
    }
    return result;
}
```

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14. Consider the following output:

```
6   5   4   3   2   1
5   4   3   2   1
4   3   2   1
3   2   1
2   1
1
```

Which of the following code segments produces the above output when executed?

(A)
```
for  (int j = 6;  j  <  0;  j--)
{
  for (int k = j; k > 0; k--)
  {
     System.out.print(k  +  "   ");
  }
  System.out.println(" ");
}
```

(B)
```
for (int j = 6; j >= 0; j--)
{
  for (int k = j; k >= 0; k--)
  {
     System.out.print(k + " ");
  }
  System.out.println(" ");
}
```

(C)
```
for (int j = 0; j < 6; j++)
{
  for (int k = 6 - j; k > 0; k--)
  {
     System.out.print(k + "  ");
  }
  system.out.println(" ");
}
```

(D)
```
for (int j = 0; j < 6; j++)
{
  for (int k = 7 - j ; k > 0 ; k--)
  {
     System.out.print(k + " ");
  }
  System.out.println(" ");
}
```

(E)
```
for (int j = 0; j < 6; j++)
{
  for (int k = 6  -  j ; k >= 0; k--)
  {
     System.out.print(k + " ");
  }
  System.out.println(" ");
}
```

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15. Consider the following code segment.

```
List<Integer> list = new ArrayList<Integer>();
list.add(new Integer(7));
list.add(new Integer(6));
list.add(1, new Integer(5));
list.add(1, new Integer(4));
list.add(new Integer(3));
list.set(2, new Integer(2));
list.add(1, new Integer(1));
System.out.println(list);
```

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

(A) `[1, 4, 2, 7, 6, 3]`
(B) `[7, 1, 4, 2, 6, 3]`
(C) `[7, 2, 5, 4, 3, 1]`
(D) `[7, 6, 2, 4, 3, 1]`
(E) `[7, 1, 2]`

16. Consider the following declarations.

```
public class Animal
{
    String makeSound()
    {
        // Implementation not shown
    }
    String animalType()
    {
        // Implementation not shown
    }
}
public static class Dog extends Animal
{
    public String makeSound(Animal a)
    {
        // Implementation not shown
    }
}
```

Which of the following methods must be included in the declaration of the `Dog` class in order for the class to successfully compile?

I. `public String makeSound()`
II. `public String animalType()`
III. `public String animalType(Animal b)`

(A) I only
(B) II only
(C) I and II only
(D) II and III only
(E) None

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17. Consider the following two classes.

```
public class Fish
{
  public String endoskeleton = "bone";

  public void action()
  {
      System.out.println("splash splash");
  }
}

public class Shark extends Fish
{
  public void action()
  {
      System.out.println("chomp chomp");
  }

  public String endoskeleton = "cartilage";
}
```

Which of the following is the correct output after the following code segment is executed?

```
Fish Bob = new Shark();
System.out.println(Bob.endoskeleton);
Bob.action();
```

(A) bone
chomp chomp

(B) bone
splash splash

(C) cartilage
splash splash

(D) cartilage
chomp chomp

(E) cartilage
splash splash
chomp chomp

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Questions 18–19 refer to the following incomplete method.

The following `insertSort` method sorts the values in an integer array, `sort`, in ascending order.

```
1   public static void insertSort(int[] sort)
2      {
3         for (int index = 1;index < sort.length;index++)
4         {
5         int temp = sort[index];
6         while (index > 0 && sort[index - 1] > temp)
7               {
8         /* missing code */
9               }
10     sort[index] = temp;
11        }
12    }
```

18. Which of the following can be used to replace /* *missing code* */ so that the `insertSort` method will execute properly?

(A)
```
sort[index] = sort[index - 1];
index++;
```
(B)
```
sort[index - 1] = sort[index];
index--;
```
(C)
```
sort[index] = sort[index + 1];
index++;
```
(D)
```
sort[index] = sort[index - 1];
index--;
```
(E)
```
sort[index] = sort[index + 1];
index--;
```

19. Assuming that the /* *missing code* */ is implemented properly, what change can be made to the code in order for the array to be sorted in descending order?

(A) Replace Line 6 with: `while (index < 0 && sort[index - 1] > temp)`
(B) Replace Line 6 with: `while (index < 0 && sort[index - 1] < temp)`
(C) Replace Line 6 with: `while (index > 0 && sort[index - 1] < temp)`
(D) Replace Line 3 with: `for (int index = sort.length - 1;index > 0;index--)`
(E) Replace Line 3 with: `for (int index = 1;index > 0;index--)`

20. Which of the following arrays would be sorted the slowest using insertion sort?

(A) `[3 4 6 2 7 3 9]`
(B) `[3 2 5 4 6 7 9]`
(C) `[9 7 6 5 4 3 2]`
(D) `[2 3 4 5 6 7 9]`
(E) `[9 3 2 4 5 7 6]`

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Questions 21–23 refer to the following incomplete class declaration used to represent fractions with integer numerators and denominators.

```
public class Fraction
{
  private int numerator;
  private int denominator;

  public Fraction()
  {
      numerator = 0;
      denominator = 1;
  }

  public Fraction(int n, int d)
  {
      numerator = n;
      denominator = d;
  }

  // postcondition: returns the
  //     numerator
  public int getNumerator()
  {   /* implementation not shown */  }

  // postcondition: returns the
  //     denominator
  public int getDenominator()
  {   /* implementation not shown*/   }

  // postcondition: returns the greatest
  // common divisor of x and y
  public int gcd(int x, int y)
  {   /* implementation not shown*/   }

  // postcondition: returns the Fraction
  //     that is the result of multiplying
  //     this Fraction and f

  public Fraction multiply(Fraction f)
  {   /* implementation not shown */  }
  // . . . other methods not shown
}
```

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21. Consider the method `multiply` of the `Fraction` class.

```
// postcondition: returns the Fraction
//                that is the result of multiplying
//                this Fraction and f
public Fraction multiply(Fraction f)
{  /* missing code */  }
```

Which of the following statements can be used to replace `/* missing code */` so that the `multiply` method is correctly implemented?

I.
```
return Fraction(
  numerator * f.getNumerator(),
  denominator * f.getDenominator());
```

II.
```
return new Fraction(
  numerator * f.numerator,
  denominator * f.denominator());
```

III.
```
return new Fraction(
  numerator * f.getNumerator(),
  denominator * f.getDenominator());
```

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

22. Consider the use of the `Fraction` class to multiply the fractions $\frac{3}{4}$ and $\frac{7}{19}$. Consider the following code:

```
Fraction fractionOne;
Fraction fractionTwo;
Fraction answer;
fractionOne = new Fraction(3, 4);
fractionTwo = new Fraction(7, 19);
/* missing code */
```

Which of the following could be used to replace `/* missing code */` so that the answer contains the result of multiplying fractionOne by fractionTwo?

(A) `answer = fractionOne * fractionTwo`
(B) `answer = multiply(fractionOne,fractionTwo);`
(C) `answer = fractionOne.multiply(fractionTwo);`
(D) `answer = new Fraction(fractionOne,fractionTwo);`
(E)
```
answer = (fractionOne.getNumerator() * fractionTwo.getNumerator()) /
         (fractionOne.getDenominator() * fractionTwo.getDenominator());
```

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23. The following incomplete class declaration is intended to extend the `Fraction` class so that fractions can be manipulated in reduced form (lowest terms).

Note that a fraction can be reduced to lowest terms by dividing both the numerator and denominator by the greatest common divisor (gcd) of the numerator and denominator.

```
public class ReducedFraction extends Fraction
{
   private int reducedNumerator;
   private int reducedDenominator;
   // . . . constructors and other methods not shown
}
```

Consider the following proposed constructors for the `ReducedFraction` class:

I.
```
public ReducedFraction( )
{
  reducedNumerator = 0;
  reducedDenominator = 1;
}
```

II.
```
public ReducedFraction(int n, int d)
{
  numerator = n;
  denominator = d;
  reducedNumerator = n / gcd(n, d);
  reducedDenominator = d / gcd(n, d);
}
```

III.
```
public ReducedFraction(int n, int d)
{
  super(n, d);
  reducedNumerator = n / gcd(n, d);
  reducedDenominator = d / gcd(n, d);
}
```

Which of these constructor(s) would be legal for the `ReducedFraction` class?

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

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24. Consider `s1` and `s2` defined as follows.

```
String s1 = new String("hello");
String s2 = new String("hello");
```

Which of the following is/are correct ways to see if `s1` and `s2` hold identical strings?

I.
```
if (s1 == s2)
  /* s1 and s2 are identical */
```

II.
```
if (s1.equals(s2))
  /* s1 and s2 are identical */
```

III.
```
if (s1.compareTo(s2) == 0)
  /* s1 and s2 are identical */
```

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

25. Consider the following variable and method declarations:

```
String s;
String t;
public void mystery (String a, String b)
{
   a = a + b;
   b = b + a;
}
```

Assume that `s` has the value "`Elizabeth`" and `t` has the value "`Andrew`" and `mystery(s, t)` is called. What are the values of `s` and `t` after the call to `mystery`?

	`s`	`t`
(A)	Elizabeth	Andrew
(B)	ElizabethAndrew	AndrewElizabeth
(C)	ElizabethAndrew	AndrewElizabethAndrew
(D)	ElizabethAndrew	ElizabethAndrewAndrew
(E)	ElizabethAndrewElizabeth	AndrewElizabethAndrew

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26. Consider the following incomplete and *incorrect* class and interface declarations:

```
public class Comparable Object
{
   public int compareTo(Object o)
   {
      //method body not shown
   }
//other methods and variables not shown
}
public class Point extends ComparableObject
{
   private int x;
   private int y;
   public boolean compareTo(Point other)
   {
      return (x == other.x &&
              y == other.y);
   }
   // . . . constructors and other methods
   //    not shown
}
```

For which of the following reasons is the above class structure incorrect?

I. Objects may not access private data fields of other objects in the same class.
II. The `ComparableObject` class requires that `compareTo` be passed as an `Object` rather than a `Point`.
III. The `ComparableObject` class requires that `compareTo` return an `int` rather than a `boolean`.

(A) I only
(B) III only
(C) I and III only
(D) II and III only
(E) None, the above class declarations are correct.

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27. Consider the following abstraction of a `for` loop where `<1>`, `<2>`, `<3>`, and `<4>` represent legal code in the indicated locations:

```
for (<1>; <2>; <3>)
{
   <4>
}
```

Which of the following `while` loops has the same functionality as the above `for` loop?

(A)
```
<1>;
while (<2>)
{
   <3>;
   <4>
}
```

(B)
```
<1>;
while (<2>)
{
   <4>
   <3>;
}
```

(C)
```
<1>;
   while (!<2>)
{
   <3>;
   <4>
}
```

(D)
```
<1>;
while (!<2>)
{
   <4>
   <3>;
}
```

(E)
```
<1>;
<3>;
while (<2>)
{
   <4>
   <3>;
}
```

28. Consider the following expression:

```
a / b + c - d % e * f
```

Which of the expressions given below is equivalent to the one given above?

(A) `((a / b) + (c - d)) % (e * f)`
(B) `((((a / b) + c) - d) % e) * f`
(C) `((a / b) + c) - (d % (e * f)`
(D) `(a / ((b + c) - d) % e) * f`
(E) `((a / b) + c) - ((d % e) * f)`

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29. Assume that a program declares and initializes x as follows:

```
String[] x ;
x = new String[10] ;
initialize(x);              // Fills the array x with
                            // valid strings each of
                            // length 5
```

Which of the following code segments correctly traverses the array and prints out the first character of all ten strings followed by the second character of all ten strings, and so on?

I.
```
int i;
int j;
for (i = 0 ; i < 10 ; i++)
     for (j = 0 ; j < 5 ; j++)
          System.out.print(x[i].substring(j, j + 1));
```

II.
```
int i;
int j;
for (i = 0 ; i < 5 ; i++)
     for (j = 0 ; j < 10 ; j++)
          System.out.print(x[j].substring(i, i + 1));
```

III.
```
int i ;
int j ;
for (i = 0 ; i < 5 ; i++)
     for (j = 0 ; j < 10 ; j++)
          System.out.print(x[i].substring(j, j + 1));
```

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

30. Consider the following declaration and assignment statements:

```
int a = 7;
int b = 4;
double c;
c = a / b;
```

After the assignment statement is executed, what's the value of `c`?

(A) 1.0
(B) 1.75
(C) 2.0
(D) An error occurs because `c` was not initialized.
(E) An error occurs because `a` and `b` are integers and `c` is a double.

GO ON TO THE NEXT PAGE.

31. Consider the following code segment:

```
int x;
x = /* initialized to an integer */
if (x % 2 == 0 && x / 3 == 1)
   System.out.print("Yes");
```

For what values of x will the word "Yes" be printed when the code segment is executed?

(A) 0
(B) 4
(C) Whenever x is even and x is not divisible by 3
(D) Whenever x is odd and x is divisible by 3
(E) Whenever x is even and x is divisible by 3

32. Consider the following incomplete class definition:

```
public class SomeClass
{
   private String myName;
   // postcondition: returns myName
   public String getName( )
   { /* implementation not shown */ }
   // postcondition: myName == name
   public void setName(String name)
   { /* implementation not shown */ }
   // . . . constructors, other methods
   //    and private data not shown
}
```

Now consider the method `swap`, not part of the `SomeClass` class.

```
// precondition: x and y are correctly
//    constructed
// postcondition: the names of objects
//    x and y are swapped
public void swap (SomeClass x, SomeClass y)
{
   /* missing code */
}
```

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Which of the following code segments can replace */* *missing code* */* so that the method swap works as intended?

I.
```
SomeClass temp;
temp = x;
x = y;
y = temp;
```

II.
```
String temp;
temp = x.myName;
x.myName = y.myName;
y.myName = temp;
```

III.
```
String temp;
temp = x.getName();
x.setName(y.getName());
y.setName(temp);
```

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

33. A bookstore wants to store information about the different types of books it sells.

For each book, it wants to keep track of the title of the book, the author of the book, and whether the book is a work of fiction or nonfiction.

If the book is a work of fiction, then the bookstore wants to keep track of whether it is a romance novel, a mystery novel, or science fiction.

If the book is a work of nonfiction, then the bookstore wants to keep track of whether it is a biography, a cookbook, or a self-help book.

Which of the following is the best design?

(A) Use one class, `Book`, which has three data fields: `String title`, `String author`, and `int bookType`.
(B) Use four unrelated classes: `Book`, `Title`, `Author`, and `BookType`.
(C) Use a class `Book` which has two data fields: `String title`, `String author`, and a subclass: `BookType`.
(D) Use a class `Book` which has two data fields: `String title`, `String author`, and six subclasses: `RomanceNovel`, `Mystery`, `ScienceFiction`, `Biography`, `Cookbook`, and `SelfHelpBook`.
(E) Use a class `Book` which has two data fields: `String title`, `String author`, and two subclasses: `FictionWork` and `NonFictionWork`. The class `FictionWork` has three subclasses, `RomanceNovel`, `Mystery`, and `ScienceFiction`. The class `NonFictionWork` has three subclasses: `Biography`, `Cookbook`, and `SelfHelpBook`.

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34. Consider the following code:

```
public int mystery(int x)
{
   if (x == 1)
      return <missing value>;
   else
      return(2 * mystery(x - 1)) + x;
}
```

Which of the following can be used to replace `<missing value>` so that `mystery (4)` returns `34` ?

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

35. Consider the following code segment:

```
int [ ] X;
int [ ] Y;
int k;
X = initializeX();        // returns a valid
                          // initialized int [ ]
Y = initializeY();        // returns a valid
                          // initialized int [ ]
for (k = 0;
   k < X.length && X[k] == Y[k];
   k++)
{
   /* some code */
}
```

Assuming that after `X` and `Y` are initialized, `X.length == Y.length`, which of the following must be true after executing this code segment?

(A) `k < X.length`
(B) `k < X.length && X[k] == Y[k]`
(C) `k < X.length && X[k] != Y[k]`
(D) `k >= X.length || X[k] == Y[k]`
(E) `k >= X.length || X[k] != Y[k]`

36. Which of the following would *not* cause a run-time exception?

(A) Dividing an integer by zero
(B) Using an object that has been declared but not instantiated
(C) Accessing an array element with an array index that is equal to the length of the array
(D) Attempting to create a substring beginning at a negative index
(E) Attempting to call a method with the wrong number of arguments

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37. Assume that a and b are properly initialized variables of type `Double`.

Which of the following is an equivalent expression to:

```
a.doubleValue()   != b.doubleValue()
```

(A) `a != b`
(B) `a.notEquals(b)`
(C) `!(a.doubleValue() .equals(b.doubleValue()))`
(D) `!(a.compareTo(b))`
(E) `a.compareTo(b) != 0`

38. Which of the following would be the LEAST effective way of ensuring reliability in a program?

(A) Encapsulating functionality in a class by declaring all data fields to be public
(B) Defining and following preconditions and postconditions for every method
(C) Including assertions at key places in the code
(D) Using descriptive variable names
(E) Indenting code in a consistent and logical manner

39. Consider a dictionary that has 1,024 pages with 50 words on each page.

In order to look up a given target word, a student is considering using one of the following three methods:

Method 1

Use a binary search technique to find the correct page (comparing the target word with the first word on a given page). When the correct page is found, use a sequential search technique to find the target word on the page.

Method 2

Use a sequential search technique to find the correct page (comparing the target word with the first word on a given page). When the correct page is found, use another sequential search technique to find the target word on the page.

Method 3

Use a sequential search technique on all of the words in the dictionary to find the target word.

Which of the following best characterizes the greatest number of words that will be examined using each method?

	Method 1	Method 2	Method 3
(A)	10	50	1,024
(B)	55	512	2,560
(C)	55	537	25,600
(D)	60	1,074	1,074
(E)	60	1,074	51,200

GO ON TO THE NEXT PAGE.

40. Consider the following recursive method.

```
public static int mystery(int m)
{
   if (m == 0)
   {
      return 0;
   }
   else
   {
      return 4 + mystery(m - 2);
   }
}
```

Assuming that j is a positive integer and that m = 2j, what value is returned as a result of the call `mystery(j)`?

(A) `0`
(B) `m`
(C) `2m`
(D) `j`
(E) `2j`

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.

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.

FREE-RESPONSE QUESTIONS

1. In a certain school, students are permitted to enroll in one elective class from a list of electives offered. Because there are a limited number of spaces in each class for students, and because some electives are more popular than others, a lottery system was devised by the school to assign students to electives.

   Each student lists three choices for electives. The school orders the students randomly and assigns each student to the first available elective in the student's list of three choices. If none of the three choices is available (because those electives are fully enrolled), the school does not assign the student to an elective.

   After the school attempts to assign all of the students to electives, it produces a list of students it was unable to assign.

   For example, suppose there are six electives available to students: Astronomy, Ballroom Dance, Basket Weaving, Constitutional Law, Marine Biology, and Programming.

   The following table shows the name, maximum enrollment, and current enrollment for six electives after 64 students have been successfully assigned to electives:

Elective Name	Maximum Enrollment	Current Enrollment
Astronomy	12	12
Ballroom Dance	20	3
Basket Weaving	15	14
Constitutional Law	10	7
Marine Biology	10	10
Programming	18	18

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Note that three electives, Astronomy, Programming, and Marine Biology, are fully enrolled and are no longer options for students.

Now suppose that the following students need to be assigned to electives:

Student	First Choice `getChoice (0)`	Second Choice `getChoice (1)`	Third Choice `getChoice (2)`
Andrew	Programming	Marine Biology	Ballroom Dance
David	Constitutional Law	Basket Weaving	Programming
Elizabeth	Marine Biology	Programming	Astronomy
Ethan	Basket Weaving	Marine Biology	Astronomy
Katharine	Programming	Basket Weaving	Marine Biology

Andrew's first and second choices are fully enrolled, but his third choice has openings. Andrew will be enrolled in Ballroom Dance.

David's first choice has openings. David will be enrolled in Constitutional Law.

All three of Elizabeth's choices are fully enrolled. Elizabeth will remain unassigned to an elective.

Ethan's first choice has one opening left. Ethan will be enrolled in Basket Weaving. Note that Basket Weaving is now fully enrolled.

All three of Katharine's choices are now fully enrolled. Katharine will remain unassigned to an elective.

In this problem, the school is modeled by the class `School`. Students and electives are modeled by the classes `Student` and `Elective`, respectively.

The `School` class includes the following methods and private data:

- `studentList`—This `ArrayList` holds the list of students in the order in which the students should be scheduled.
- `electiveList`—This `ArrayList` holds the electives that students may choose.
- `getElectiveByName`—This method returns the `Elective` in `electiveList` with the given name.
- `assignElectivesToStudents`—This method encapsulates the functionality of assigning students (if possible) their first, second, or third elective choice.
- `studentsWithoutElectives`—This method returns an `ArrayList` containing students that have not been assigned an elective.

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```
public class School
{
    private ArrayList<Student> studentList;
    // each element is an instance of a
    // Student representing one student
    // at the school; students are in
    // the order they should be scheduled

    private ArrayList<Elective> electiveList;
    // each element is an instance of an
    // Elective representing one elective
    // offered at the school

    // precondition: name is the name of an
    //          Elective in electiveList
    // postcondition: returns the Elective
    //          in electiveList with the given
    //          name
    private Elective getElectiveByName (String name)
    { /* to be implemented in part (a) */ }
    // postcondition: returns the size
    //    of electiveList
    private int getElectiveListSize()
    {
       return electiveList.size();
    }
    private int getStudentListSize()
    {
       return studentList.size();
    }

    // postcondition: All Students in
    //          studentList have been either
    //          assigned their first available
    //          elective choice or not assigned;
    //          All Electives in electiveList have
    //          been updated appropriately as
    //          Students are assigned to them
    public void assignElectivesToStudents()
    { /* to be implemented in part (b) */ }

    // postcondition: returns a list of
    //          those Students who have not been
    //          assigned an Elective
    public ArrayList<Student>
       studentsWithoutElectives()
    { /* to be implemented in part (c) */}

    // ... constructors, other methods,
    //          and other private data not shown
}
```

GO ON TO THE NEXT PAGE.

The Student class includes the following methods and private data:

- `getChoice`—This method returns the name of the given elective choice of the student. The first elective choice has index 0, the second has index 1, and the third has index 2.
- `hasElective`—This method returns true if the student has been assigned an elective; it returns false otherwise.
- `assignElective`—This method assigns the given elective to this student.

```
public class Student
{
    // precondition: 0 <= index < 3
    // postcondition: returns the name
    //        of the given elective choice
    public String getChoice(int index)
    { /* code not shown */}

    // postcondition: returns true if
    //        an Elective has been assigned
    //        to this Student
    public boolean hasElective()
    { /* code not shown */ }

    // precondition: e is not null
    // postcondition: e has been assigned
    //        to this Student; e has not been
    //        modified
    public void assignElective(Elective e)
    { /* code not shown */ }

    // ... constructors, other methods,
    //    and other private data not shown
}
```

The Elective class includes the following methods:

- `getName`—This method returns the name of this elective.
- `getMaxClassSize`—This method returns the maximum number of students that can be assigned to this elective.
- `getClassSize`—This method returns the number of students that have been assigned to this elective.
- `addStudent`—This method assigns the given student to this elective.

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```
public class Elective
{
    private String name;
    private in maxClassSize;
    private int classSize;
    private ArrayList studentList = new ArrayList();

    // postcondition: returns the name
    //        of this Elective
    public String getName()
    { /* code not shown */ }

    // postcondition: returns the
    //        maximum number of Students
    //        that can be added to this
    //        Elective
    public int getMaxClassSize()
    { /* code not shown */ }

    // postcondition: returns the
    //        number of Students that have
    //        been added to this Elective;
    //        0 < = getClassSize ( ) < =
    //        getMaxClassSize ( )
    public int getClassSize()
    { /* code not shown */ }

    // precondition: getClassSize ( ) <
    //        getMaxClassSize ( ); s is not null
    // postcondition: s has been added to
    //        this Elective; getClassSize ( ) has
    //        been increased by 1
    public void addStudent(Student s)
    { /* code not shown */ }

    // constructors, other methods, and other private data not shown
}
```

(a) Write the `School` method `getElectiveByName`. Method `getElectiveByName` should return the `Elective` in `electiveList` that has the given name.

Complete method `getElectiveByName` below.

```
// precondition: name is the name of an
//        Elective in electiveList
// postcondition: returns the Elective in
//        electiveList with the given name
private Elective getElectiveByName(String name)
```

GO ON TO THE NEXT PAGE.

(b) Write the `School` method `assignElectivesToStudents`. Method `assignElectivesToStudents` should assign electives to students as described at the beginning of this question.

In writing method `assignElectivesToStudents`, you may use the `private` helper method `getElectiveByName` specified in part (a). Assume that `getElectiveByName` works as specified, regardless of what you wrote in part (a). Solutions that reimplement functionality provided by this method, rather than invoking it, will not receive full credit.

Complete method `assignElectivesToStudents` below

```
// postcondition: All Students in
//                studentList have been either
//                assigned their first available
//                elective choice or not assigned;
//                All electives in electiveList have
//                been updated appropriately as
//                Students are assigned to them
public void assignElectivesToStudents()
```

GO ON TO THE NEXT PAGE.

(c) Write the `School` method `studentsWithoutElectives`. Method `studentsWithoutElectives` should return `ArrayList` of all Students in `studentList` who do not have an `Elective` assigned to them.

Complete method `studentsWithoutElectives` below

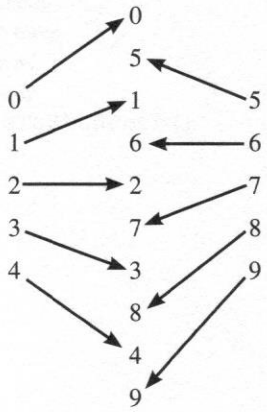
```
// postcondition: returns a list of those
//                Students who have not been assigned
//                an Elective
public ArrayList studentsWithoutElectives()
```

2. Consider a deck of n cards where n is even and each card is uniquely labeled from 1 to n.

   A *shuffle* is performed when the deck is divided into two stacks and the stacks are interlaced so that a new stack is formed by alternately taking cards from each stack.

   For instance, a deck of ten cards is in order when the card labeled 0 is on the top of the deck and the card labeled 9 is on the bottom of the deck.

   Dividing the deck in half produces two stacks of cards—one stack with cards 0 through 4, the other with cards 5 through 9. Interlacing the stacks produces a deck in the following order:



   The number of times needed to shuffle the deck until it returns to its original order is called the *reorder count*. Note that the reorder count for a deck of ten cards is six:

	Shuffle number					
Original	**1**	**2**	**3**	**4**	**5**	**6**
0	0	0	0	0	0	0
1	5	7	8	4	2	1
2	1	5	7	8	4	2
3	6	3	6	3	6	3
4	2	1	5	7	8	4
5	7	8	4	2	1	5
6	3	6	3	6	3	6
7	8	4	2	1	5	7
8	4	2	1	5	7	8
9	9	9	9	9	9	9

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A deck is modeled by the following incomplete declaration of the `Deck` class:

```
public class Deck
{
    private int [ ] cards;

    public Deck(int numCards)
    { /* code not shown */ }

    public boolean inOrder()
    { /* to be implemented in part (a) */ }

    public void shuffle()
    { /* to be implemented in part (b) */ }

    public int reorderingCount()
    { /* to be implemented in part (c) */ }
}
```

(a) Write the `Deck` method `inOrder`. Method `inOrder` should return true if the cards in the `deck` are in numerical order from 0 to `cards.length - 1` and should return false otherwise. Cards are in numerical order if cards [k] = = k for all 0 < = k < cards.length.

Complete method inOrder below.

```
// precondition: For all k such that
//               0 < = k < cards.length,
//               0 < = cards [k] < cards.length and
//               each card [k] is unique
// postcondition: returns true if
//               cards [k] = = k for all
//               0 < = k < cards.length; returns
//               false otherwise
public boolean inOrder()
```

GO ON TO THE NEXT PAGE.

(b) Write the `Deck` method `shuffle`. This method should divide the deck into two equal stacks and interlace them evenly as described at the beginning of this question.

Complete method `shuffle` below.

```
// postcondition: the deck is shuffled by
//                dividing the deck into two equal stacks
//                that are evenly interlaced
public void shuffle()
```

GO ON TO THE NEXT PAGE.

(c) Write the `Deck` method `reorderCount`. Method `reorderCount` should return the number of shuffles necessary to return the deck to its original order.

In writing method `reorderCount`, you may use the methods `inOrder` and shuffle as specified in parts (a) and (b). Assume that `inOrder` and shuffle work as specified, regardless of what you wrote in parts (a) and (b). Solutions that reimplement functionality provided by these methods, rather than invoking them, will not receive full credit.

Complete method `reorderCount` below.

```
// postcondition: returns the number of
//                shuffles necessary to return the cards
//                in the deck to their original numerical
//                order such that inOrder ( ) = = true; the
//                cards in the deck are in their original
//                numerical order
public int reorderCount()
```

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3. Consider the design of an electronic cookbook modeled with the following class declarations:

```
public class Cookbook

{
   private ArrayList recipeList;  // each entry is an instance of a Recipe representing one recipe in the cookbook


   /* precondition: numPeople > 0
    * postcondition: All recipes in recipeList have been converted to serve numPeople number of people
   */
   public void standardize(int numPeople)

   { /* code not shown */ }

   // ... constructors, other methods, and other private data not shown
}

public class Ingredient
{
   private String name;  // the name of this ingredient
   private double amount;  // the amount of this ingredient needed in the recipe

   // @returns the amount of this ingredient needed in the recipe
   public double getAmount()
   { /* code not shown */ }

   /** precondition: amt > 0.0
    * postcondition: amount has been set // to amt
   */
   public void setAmount (double amt)
   { /* code not shown */ }

   /* precondition: newNumber > 0
    * postcondition: numberServed has been set to newNumber
   */
   public void setNumberServed(int newNumber)
   { /* code not shown */ }

   // ... constructors and other methods not shown


}
```

GO ON TO THE NEXT PAGE.

(a) A recipe in the cookbook is modeled by the class `Recipe` with the following data and operations:

Data

- the name of the recipe
- the list of ingredients used in the recipe
- the description of the preparation process for the recipe
- the number of people served by the recipe

Operations

- create a recipe with a given name and number of people served
- add an ingredient to the recipe
- set the description of the preparation process for the recipe
- return the name of the recipe
- return the list of ingredients
- return the number of people served by the recipe
- scale the recipe to serve a given new number of people by changing the amount of each ingredient appropriately

Write the definition of the class `Recipe`, showing the appropriate data definitions and constructor and method signatures. You should *not* write the implementations of the constructor or methods for the `Recipe` class.

(b) Using the signature you wrote in part (a), write the implementation for the method that scales the recipe to serve a given new number of people.

In writing this method, you may call any of the methods in the `Recipe` class (as you defined it in part (a)) or in the `Ingredient` class. Assume that these methods work as specified.

(c) Write the `Cookbook` method `standardize` as described at the beginning of the question.

In writing this method, you may call any of the methods in the `Recipe` class (as you defined it in part (a)). Assume that these methods work as specified.

Complete method `standardize` below.

```
// precondition: numPeople > 0
// postcondition: All recipes in
//                recipeList have been scaled to
//                serve numPeople number of people
public void standardize(int numPeople)
```

GO ON TO THE NEXT PAGE.

4. Consider a school that contains x number of students that all start their first period class in one of n classrooms. This scenario can be represented using three classes. The `School` class contains an array of all the `Classrooms` in the school. The `Classroom` class has fields for the teacher in charge of the room `teacherName` and an array of all the `Students` in the classroom `Students`. The `Student` class has a field for the name of the student `studentName` and the ID number of the student `studentID`.

   The `School` class contains a method `findStudent` that takes a teacher's name and a student ID as arguments and returns the name of the student. The method utilizes a sequential search algorithm to find the correct classroom and a binary search algorithm to find the correct student. If the student is not found in the classroom of which the given teacher is in charge, the method returns "`Student Not Found`."

   Write the complete `School`, `Classroom`, and `Student` classes, including any instance variables, constructors, and necessary methods. You may assume that the student ID numbers in each classroom are sorted in ascending order.

STOP

END OF EXAM