Practice Tests

How to Calculate Your (Approximate) AP Computer Science A Score

Multiple Choice

Number correct (out of 40) = ____________ ⟸ Multiple-Choice Score

Free Response

Question 1 ____________
(out of 9)

Question 2 ____________
(out of 9)

Question 3 ____________
(out of 9)

Question 4 ____________
(out of 9)

Total ____________ × 1.11 = ____________ ⟸ Free-Response Score
(Do not round.)

Final Score

____________ + ____________ = ____________
Multiple-Choice Score | Free-Response Score | Final Score (Round to nearest whole number.)

Chart to Convert to AP Grade
Computer Science A

Final Score Range	AP Grade[a]
62–80	5
47–61	4
37–46	3
29–36	2
0–28	1

[a]The score range corresponding to each grade varies from exam to exam and is approximate.

Practice Test 1

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 scratchwork. Then decide which is the best of the choices given and fill in the corresponding oval on the answer sheet. Do not spend too much time on any one problem.

NOTES:

- Assume that the classes in the Quick Reference have been imported where needed.
- Assume that variables and methods are declared within the context of an enclosing class.
- Assume that method calls that have no object or class name prefixed, and that are not shown within a complete class definition, appear within the context of an enclosing class.
- Assume that parameters in method calls are not null unless otherwise stated.

1. A large Java program was tested extensively, and no errors were found. '
   can be concluded?

(A) All of the preconditions in the program are correct.
(B) All of the postconditions in the program are correct.
(C) The program may have bugs.
(D) The program has no bugs.
(E) Every method in the program may safely be used in other programs.

Questions 2–4 refer to the `Worker` class below.

```
public class Worker
{
   private String name;
   private double hourlyWage;
   private boolean isUnionMember;

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

   public Worker(String aName, double anHourlyWage,
boolean union)
   { /* implementation not shown */ }

   //Accessors getName, getHourlyWage, getUnionStatus are
not shown.

   /** Permanently increase hourly wage by amt.
    *  @param amt the amount of wage increase
    */
   public void incrementWage(double amt)
   { /* implementation of incrementWage */ }

   /** Switch value of isUnionMember from true to false
and
    *  vice versa.
    */
   public void changeUnionStatus()
   { /* implementation of changeUnionStatus */ }
   }
```

2. Refer to the `incrementWage` method. Which of the following is a correct

`/*` ***implementation of*** `incrementWage */`?

(A) `return hourlyWage + amt;`

(B) `return getHourlyWage() + amt;`

(C) `hourlyWage += amt;`

(D) `getHourlyWage() += amt;`

(E) `hourlyWage = amt;`

3. Consider the method `changeUnionStatus`. Which is a correct

   /* ***implementation of*** `changeUnionStatus` */?

   I
   ```
   if (isUnionMember)
       isUnionMember = false;
   else
       isUnionMember = true;
   ```

   II
   ```
   isUnionMember = !isUnionMember;
   ```

   III
   ```
   if (isUnionMember)
       isUnionMember = !isUnionMember;
   ```

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

4. A client method `computePay` will return a worker's pay based on the nu
   of hours worked.

```
/** Precondition: Worker w has worked the given number of
hours.
 *  @param w a Worker
 *  @param hours the number of hours worked
 *  @return amount of pay for Worker w
 */
public static double computePay(Worker w, double hours)
{ /* code */ }
```

Which replacement for /* ***code*** */ is correct?

(A) `return hourlyWage * hours;`

(B) `return getHourlyWage() * hours;`

(C) `return w.getHourlyWage() * hours;`

(D) `return w.hourlyWage * hours;`

(E) `return w.getHourlyWage() * w.hours;`

5. Consider this program segment. You may assume that `wordList` has declared as `ArrayList<String>`.

```
for (String s : wordList)
    if (s.length() < 4)
        System.out.println("SHORT WORD");
```

What is the maximum number of times that `SHORT WORD` can be printed?

(A) `3`

(B) `4`

(C) `s.length()`

(D) `wordList.size() - 1`

(E) `wordList.size()`

6. Refer to the following method.

```
public static int mystery(int n)
{
    if (n == 1)
        return 3;
   else
        return 3 * mystery(n - 1);
}
```

What value does mystery(4) return?

(A) 3

(B) 9

(C) 12

(D) 27

(E) 81

7. Refer to the following declarations.

```
String[] colors = {"red", "green", "black"};
ArrayList<String> colorList = new ArrayList<String>();
```

Which of the following correctly assigns the elements of the `colors` array to `colorList`? The final ordering of colors in `colorList` should be the same as in the `colors` array.

```
  I for (String col : colors)
        colorList.add(col);

 II for (String col : colorList)
        colors.add(col);

III for (int i = colors.length - 1; i >= 0; i--)
        colorList.add(i, colors[i]);
```

(A) I only

(B) II only

(C) III only

(D) II and III only

(E) I, II, and III

8. Often the most efficient computer algorithms use a divide-and-cor approach, for example, one in which a list is repeatedly split into two p until a desired outcome is reached. Which of the following use a divide- conquer approach?

I Merge sort

II Insertion sort

III Binary search

(A) I only

(B) II only

(C) III only

(D) I and III only

(E) I, II, and III

9. An `Insect` class is to be written, containing the following data fields. which will be initialized to 0 when an `Insect` is constructed.

`nextAvailableID`, which will be initialized to `0` outside the constructor and incremented each time an `Insect` is constructed.
`idNum`, which will be initialized to the current value of `nextAvailableID` when an `Insect` is constructed.
`position`, which will be initialized to the location in a garden where the `Insect` is placed when it is constructed.
`direction`, which will be initialized to the direction the `Insect` is facing when placed in the garden.

Which variable in the `Insect` class should be static?

(A) `age`

(B) `nextAvailableID`

(C) `idNum`

(D) `position`

(E) `direction`

Questions 10 and 11 refer to the classes `Address` and `Customer` given below.

```
public class Address
{
    private String street;
    private String city;
    private String state;
    private int zipCode;

    public Address(String aStreet, String aCity, String
aState,
            int aZipCode)
    { /* implementation not shown */ }

    //Other methods are not shown.
}

public class Customer
{
    private String name;
    private String phone;
    private Address address;
    private int ID;

    public Customer(String aName, String aPhone, Address
anAddr, int anID)
    { /* implementation not shown */ }

    public Address getAddress()
    { /* implementation not shown */ }

    public String getName()
    { /* implementation not shown */ }

    public String getPhone()
    { /* implementation not shown */ }

    public int getID()
    { /* implementation not shown */ }

    //Other methods are not shown.
}
```

10. Which of the following correctly creates a `Customer` object c?

I
```
Address a = new Address("125 Bismark St",
 "Pleasantville", "NY", 14850);
Customer c = new Customer("Jack Spratt", "747-1674", a,
7008);
```

II
```
Customer c = new Customer("Jack Spratt", "747-1674", "125
 Bismark St, Pleasantville, NY 14850", 7008);
```

III
```
Customer c = new Customer("Jack Spratt", "747-1674", new
 Address("125 Bismark St", "Pleasantville", "NY", 14850),
 7008);
```

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

11. Consider an `AllCustomers` class that has the following private inst variable.

```
private Customer[] custList;
```

Given the ID number of a particular customer, a method of the class, `locate`, must find the correct `Customer` record and return the name of that customer. Here is the method `locate`:

```
/** Returns the name of the customer with the specified
idNum.
 *  Precondition: custList contains a complete list of
Customer objects.
 */
public String locate(int idNum)
{
    for (Customer c : custList)
        if (c.getID() == idNum)
            return c.getName();
    return null; //idNum not found
}
```

A more efficient algorithm for finding the matching `Customer` object could be used if

(A) `Customer` objects were in alphabetical order by name.
(B) `Customer` objects were sorted by phone number.
(C) `Customer` objects were sorted by ID number.
(D) the `custList` array had fewer elements.
(E) the `Customer` class did not have an `Address` data member.

12. The following shuffling method is used to shuffle an array `arr` of `int` va

The method assumes the existence of a `swap` method, where `swap(arr,` interchanges the elements `arr[i]` and `arr[j]`.

```
public static void shuffle (int[] arr)
{
   for (int k = arr.length - 1; k > 0; k--)
   {
      int randIndex = (int) (Math.random() * (k + 1));
      swap(arr, k, randIndex);
   }
}
```

Suppose the initial state of `arr` is `1 2 3 4 5`, and when the method is executed the values generated for `randIndex` are `3, 2, 0`, and `1`, in that order. What will be the final state of `arr`?

(A) `5 2 1 3 4`

(B) `1 2 5 3 4`

(C) `5 4 1 3 2`

(D) `4 5 1 3 2`

(E) `2 5 1 3 4`

13. Refer to method `removeWord`.

```
/** Removes all occurrences of word from wordList.
/** Precondition:  wordList is an ArrayList of String
objects.
 *  Postcondition: All occurrences of word have been
removed
 *                 from wordList.
 */
public static void removeWord(ArrayList<String> wordList,
String word)
{
   for (int i = 0; i < wordList.size(); i++)
       if ((wordList.get(i)).equals(word))
           wordList.remove(i);
}
```

The method does not always work as intended. Consider the method call

```
removeWord(wordList, "cat");
```

For which of the following lists will this method call fail?

(A) `The cat sat on the mat`

(B) `The cat cat sat on the mat mat`

(C) `The cat sat on the cat`

(D) `cat`

(E) `The cow sat on the mat`

14. A `Clock` class has hours, minutes, and seconds represented by `int` valu
also has each of the following methods: `setTime` to change the time
`Clock` to the hour, minute, and second specified; `getTime` to access the
and `toString` to return the time as a `String`. The `Clock` class h
constructor that allows a `Clock` to be created with three `int` parameter
hours, minutes, and seconds. Consider a two-dimensional array of `C`
values called `allClocks`. A code segment manipulating `allClocks`
follows.

```
for (Clock[] row : allClocks)
    for (Clock c : row)
        /* more code */
```

Assuming the `Clock` class works as specified, which replacement for /* ***more code*** */ will cause an error?

I `System.out.print(c);`

II `c.setTime(0, 0, 0);`

III `c = new Clock(0, 0, 0);`

(A) I only

(B) II only

(C) III only

(D) II and III only

(E) I and II only

15. Consider the following method that will access a square matrix `mat`.

```
/** **Precondition:** mat is initialized and is a square
matrix.
 */
public static void printSomething(int[][] mat)
{
   for (int r = 0; r < mat.length; r++)
   {
      for (int c=0; c<=r; c++)
         System.out.print(mat[r][c] + " ");
      System.out.println();
   }
}
```

Suppose mat is originally

```
 0 1 2 3
 4 5 6 7
 3 2 1 0
 7 6 5 4
```

After the method call `printSomething(mat)` the output will be

(A)
```
0 1 2 3
4 5 6 7
3 2 1 0
7 6 5 4
```

(B)
```
0
4 5
3 2 1
7 6 5 4
```

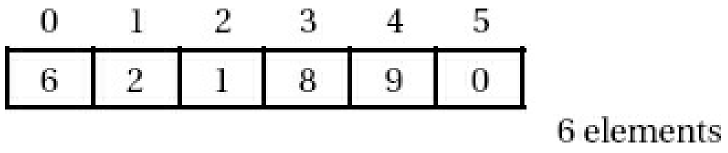
(C)
```
0 1 2 3
4 5 6
3 2
7
```

(D) `0`
```
4
3
7
```

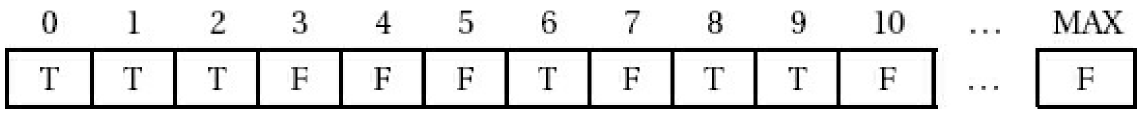
(E) There will be no output. An `ArrayIndexOutOfBoundsException` will be thrown.

16. Consider two different ways of storing a set of nonnegative integers in w there are no duplicates.

Method One: Store the integers explicitly in an array in which the number of elements is known. For example, in this method, the set {6, 2, 1, 8, 9, 0} can be represented as follows.



Method Two: Suppose that the range of the integers is 0 to MAX. Use a boolean array indexed from 0 to MAX. The index values represent the possible values in the set. In other words, each possible integer from 0 to MAX is represented by a different position in the array. A value of true in the array means that the corresponding integer is in the set, a value of false means that the integer is not in the set. For example, using this method for the same set above, {6, 2, 1, 8, 9, 0}, the representation would be as follows (T = true, F = false).



The following operations are to be performed on the set of integers.

I Search for a target value in the set.

II Print all the elements of the set.

III Return the number of elements in the set.

Which statement is true?

(A) Operation I is more efficient if the set is stored using Method One.
(B) Operation II is more efficient if the set is stored using Method Two.
(C) Operation III is more efficient if the set is stored using Method One.
(D) Operation I is equally efficient for Methods One and Two.
(E) Operation III is equally efficient for Methods One and Two.

17. An algorithm for finding the average of *N* numbers is

$$\text{average} = \frac{\text{sum}}{N}$$

where *N* and sum are both integers. In a program using this algorithm, a programmer forgot to include a test that would check for *N* equal to zero. If *N* is zero, when will the error be detected?

(A) At compile time
(B) At edit time
(C) As soon as the value of *N* is entered
(D) During run time
(E) When an incorrect result is output

18. Consider an array `arr` of 64 distinct `int` values, which are sorte increasing order. The first element of the array, `arr[0]`, equals `5`, and th element, `arr[63]`, equals `200`. A binary search algorithm will be use locate various key values. Which of the following is a true statement?

I If `5` is the key, it will take exactly 7 iterations of the search loop to locate it.

II If `2` is the key, it will take exactly 7 iterations of the search loop to determine that `2` is not in `arr`.

III If `100` is the key, and `100` is equal to `arr[62]`, it will take fewer than 7 iterations of the search loop to locate the key.

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) II and III only

19. Consider method `getCount` below.

```
public static int getCount(String s, String sub)
{
   int count = 0;
   int pos = s.indexOf(sub);
   while (pos >= 0)
   {
      s = s.substring(pos);
      count++;
      pos = s.indexOf(sub);
   }
   return count;
}
```

What will the method call `getCount("a carrot and car", "car")` return?

(A) `0`

(B) `1`

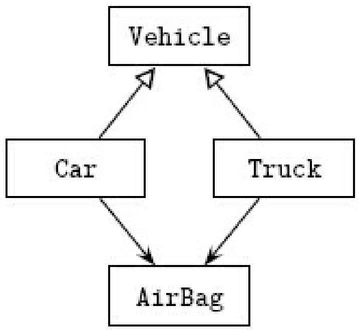
(C) `2`

(D) `3`

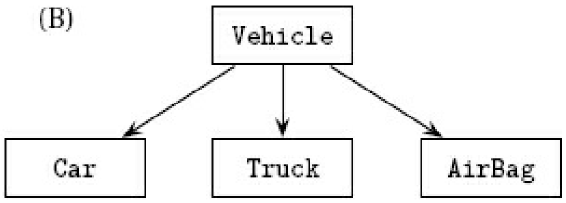
(E) No value returned. The method is in an infinite loop.

20. Consider a program that deals with various components of different veh
Which of the following is a reasonable representation of the relation
among some classes that may comprise the program? Note that an ope
arrow denotes an inheritance relationship and a down-arrow deno
composition relationship.

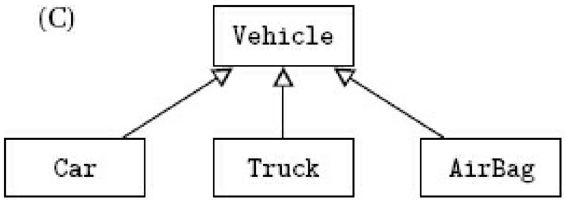
(A)



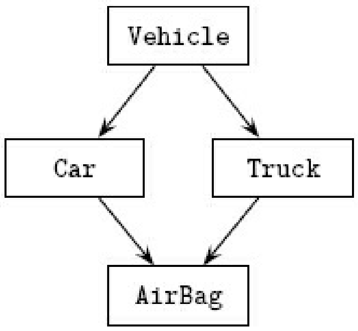
(B)



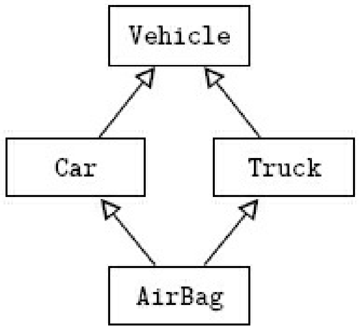
(C)



(D)



(E)



21. Consider the following program segment.

```
/** Precondition: a[0]…a[n-1] is an initialized array of
integers,
 *                and 0 < n <= a.length.
 */
    int c = 0;
    for (int i = 0; i < n; i++)
        if (a[i] >= 0)
       {
            a[c] = a[i];
            c++;
       }
   n = c;
```

Which is the best postcondition for the segment? (You may assume that `a[0]…a[-1]` represents an empty array.)

(A) `a[0]…a[n-1]` contains no positive integers.

(B) `a[0]…a[n-1]` contains no negative integers.

(C) `a[0]…a[n-1]` contains no nonnegative integers.

(D) `a[0]…a[n-1]` contains no occurrences of zero.

(E) The updated value of `n` is less than or equal to the value of `n` before execution of the segment.

22. If `a, b,` and `c` are integers, which of the following conditions is sufficie guarantee that the expression

```
a < c || a < b && !(a == c)
```

evaluates to true?

(A) `a < c`

(B) `a < b`

(C) `a > b`

(D) `a == b`

(E) `a == c`

23. Airmail Express charges for shipping small packages by integer valu weight. The charges for a weight *w* in pounds are as follows.

$0 < w \leq 2$	\$4.00
$2 < w \leq 5$	\$8.00
$5 < w \leq 20$	\$15.00

The company does not accept packages that weigh more than 20 pounds. Which of the following represents the best set of data (weights) to test a program that calculates shipping charges?

(A) 0, 2, 5, 20

(B) 1, 4, 16

(C) −1, 1, 2, 3, 5, 16, 20

(D) −1, 0, 1, 2, 3, 5, 16, 20, 22

(E) All integers from −1 through 22

24. Consider the following instance variable and methods in the same class.

```
private int[][] matrix;

/** Precondition: array.length > 0.
 *  @return the largest integer in array
 */
private int max(int[] array)
{  /* implementation not shown */ }

/** @return num1 if num1 >= num2; otherwise return num2
  */
public int max(int num1, int num2)
{ /*  implementation not shown */ }
```

Suppose matrix has a current value of

```
2 1 4 8
6 0 3 9
5 7 7 6
1 2 3 4
```

What will be returned by the following method call in the same class?

```
max(max(matrix[2]), max(matrix[3]))
```

(A) `9`

(B) `8`

(C) `7`

(D) `4`

(E) Compile-time error. No value returned.

Questions 25–26 are based on the following class declaration.

```
public class AutoPart
{
   private String description;
   private int partNum;
   private double price;

   public AutoPart(String desc, int pNum, double aPrice)
   { /* implementation not shown */ }

   public String getDescription()
   { return description; }

   public int getPartNum()
   { return partNum; }

   public double getPrice()
   { return price; }

   //Other methods are not shown.
   //There is no compareTo method.
}
```

25. This question refers to the `findCheapest` method below, which occurs class that has an array of `AutoPart` as one of its private data fields.

```
private AutoPart[] allParts;
```

The `findCheapest` method examines an array of `AutoPart` and returns the part number of the `AutoPart` with the lowest price whose description matches the `partDescription` parameter. For example, several of the `AutoPart` elements may have `"headlight"` as their description field. Different headlights will differ in both price and part number. If the `partDescription` parameter is `"headlight"`, then `findCheapest` will return the part number of the cheapest headlight.

```
/** Returns the part number of the cheapest AutoPart
 *  whose description matches partDescription.
 *  Precondition: allParts contains at least one element 
whose
 *                description matches partDescription.
 */
public int findCheapest(String partDescription)
{
    AutoPart part = null;       //AutoPart with lowest 
price so far
```

```
        double min = LARGE_VALUE;   //larger than any valid
    price
        for (AutoPart p : allParts)
        {
            /* more code */
        }
        return part.getPartNum();
    }
```

Which of the following replacements for /* ***more code*** */ will find the correct part number?

```
I if (p.getPrice() < min)
  {
     min = p.getPrice();
     part = p;
  }

II if (p.getDescription().equals(partDescription))
      if (p.getPrice() < min)
       {
          min = p.getPrice();
          part = p;
        }

III if (p.getDescription().equals(partDescription))
       if (p.getPrice() < min)
          return p.getPartNum();
```

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I and III only

26. Consider the following method.

```
    /** Returns the smaller of st1 and st2.
     *  Precondition: st1 and st2 are distinct String
    objects.
```

```
 */
public static String min(String st1, String st2)
{
   if (st1.compareTo(st2) < 0)
       return st1;
   else
      return st2;
}
```

A method in the same class has these declarations.

```
AutoPart p1 = new AutoPart(< suitable values >);
AutoPart p2 = new AutoPart(< suitable values >);
```

Which of the following statements will cause an error?

I `System.out.println(min(p1.getDescription(), p2.getDescription()));`

II `System.out.println(min(p1.toString().getDescription(), p2.toString().getDescription()));`

III `System.out.println(min(p1, p2));`

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

27. This question is based on the following declarations.

```
String strA = "CARROT", strB = "Carrot", strC = "car";
```

Given that all uppercase letters precede all lowercase letters when considering alphabetical order, which is true?

(A) `strA.compareTo(strB) < 0 && strB.compareTo(strC) > 0`
(B) `strC.compareTo(strB) < 0 && strB.compareTo(strA) < 0`

(C) `strB.compareTo(strC) < 0 && strB.compareTo(strA) > 0`

(D) `!(strA.compareTo(strB) == 0) && strB.compareTo(strA) < 0`

(E) `!(strA.compareTo(strB) == 0) && strC.compareTo(strB) < 0`

28. A programmer has a file of names. She is designing a program that s junk mail letters to everyone on the list. To make the letters sound pers and friendly, she will extract each person's first name from the name st She plans to create a parallel file of first names only. For example,

fullName	firstName
Ms. Anjali DeSouza	Anjali
Dr. John Roufaiel	John
Mrs. Mathilda Concia	Mathilda

Here is a method intended to extract the first name from a full name string.

```
/** Precondition:
 *   -  fullName starts with a title followed by a
period.
 *   -  A single space separates the title, first name,
and last name.
 * @param fullName a string containing a title, period,
blank,
 * and last name
 * @return the first name only in fullName
 */
public static String getFirstName(String fullName)
{
   final String BLANK = " ";
   String temp, firstName;

   /* code to extract first name */

   return firstName;
}
```

Which represents correct /* ***code to extract first name*** */?

I `int k = fullName.indexOf(BLANK);`

```
   temp = fullName.substring(k + 1);
   k = temp.indexOf(BLANK);
   firstName = temp.substring(0, k);
```

```
II int k = fullName.indexOf(BLANK);
   firstName = fullName.substring(k + 1);
   k = firstName.indexOf(BLANK);
   firstName = firstName.substring(0, k);
```

```
III int firstBlank = fullName.indexOf(BLANK);
    int secondBlank = fullName.indexOf(BLANK);
    firstName    =    fullName.substring(firstBlank    +    1,
  secondBlank + 1);
```

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I, II, and III

Questions 29–31 refer to the `ThreeDigitInteger` and `ThreeDigitCode` classes below.

```
public class ThreeDigitInteger
{
   private int hundredsDigit;
   private int tensDigit;
   private int onesDigit;
   private int value;

   public ThreeDigitInteger(int aValue)
   { /* implementation not shown */ }

   /** Returns the sum of digits for this
ThreeDigitInteger. */
   public int digitSum()
   { /* implementation not shown */ }

   /** Returns the sum of the hundreds digit and tens
digit. */
   public int twoDigitSum()
   { /* implementation not shown */ }
   //Other methods are not shown.
}

public class ThreeDigitCode extends ThreeDigitInteger
{
   private boolean isValid;

   public ThreeDigitCode(int aValue)
   { /* implementation code */ }

   /** A ThreeDigitCode is valid if and only if the
remainder when
    * the sum of the hundreds and tens digits is divided
by 7 equals
    * the ones digit. Thus 362 is valid while 364 is not.
    * Returns true if ThreeDigitCode is valid, false
otherwise.
    */
   public boolean isValid()
   { /* implementation not shown */ }
}
```

29. Which is a true statement about the classes shown?

(A) The `ThreeDigitInteger` class inherits the `isValid` method from the class `ThreeDigitCode`.

(B) The `ThreeDigitCode` class inherits all of the public accessor methods from the `ThreeDigitInteger` class.

(C) The `ThreeDigitCode` class inherits the constructor from the class `ThreeDigitInteger`.

(D) The `ThreeDigitCode` class can directly access all the private variables of the `ThreeDigitInteger` class.

(E) The `ThreeDigitInteger` class can access the `isValid` instance variable of the `ThreeDigitCode` class.

30. Which is correct /* ***implementation code*** */ for the `ThreeDigit` constructor?

```
 I super(aValue);
isValid = isValid();
```

II `super(value, valid);`

III
```
super(value);
isValid = twoDigitSum() 7 == onesDigit;
```

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

31. Refer to these declarations in a client program.

```
ThreeDigitInteger code = new ThreeDigitCode(127);
ThreeDigitInteger num = new ThreeDigitInteger(456);
ThreeDigitCode newCode = new ThreeDigitCode(241);
```

Which of the following subsequent tests will not cause an error?

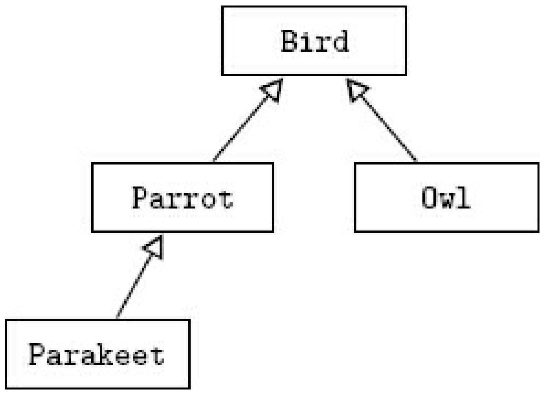
I
```
if (code.isValid())
    ...
```

II
```
if (num.isValid())
    ...
```

III
```
if (newCode.isValid())
    ...
```

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

32. Consider the following hierarchy of classes.



Assuming that each class has a valid default constructor, which of the following declarations in a client program are correct?

```
I Bird b1 = new Parrot();
  Bird b2 = new Parakeet();
  Bird b3 = new Owl();

II Parakeet p = new Parrot();
   Owl o = new Bird();

III Parakeet p = new Bird();
```

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

33. Consider an array `arr` and a `list` list that is an `ArrayList<String>`. `arr` and `list` are initialized with string values. Which of the following segments correctly appends all the strings in `arr` to the end of `list`?

```
I for (String s : arr)
      list.add(s);

II for (String s : arr)
       list.add(list.size(), s);
```

```
III for (int i = 0; i < arr.length; i++)
        list.add(arr[i]);
```

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

34. Refer to the `nextIntInRange` method below.

```
/** Returns a random integer in the range low to high,
inclusive. */
public int nextIntInRange(int low, int high)
{
   return /* expression */
}
```

Which /* ***expression*** */ will always return a value that satisfies the postcondition?

(A) `(int) (Math.random() * high) + low;`
(B) `(int) (Math.random() * (high - low)) + low;`
(C) `(int) (Math.random() * (high - low + 1)) + low;`
(D) `(int) (Math.random() * (high + low)) + low;`
(E) `(int) (Math.random() * (high + low - 1)) + low;`

35. Consider the following `mergeSort` method and the private instance varia both in the same `Sorter` class.

```
private int[] a;

/** Sorts a[first] to a[last] in increasing order using
merge sort. */
public void mergeSort(int first, int last)
{
   if (first != last)
   {
      int mid = (first + last) / 2;
      mergeSort(first, mid);
      mergeSort(mid + 1, last);
      merge(first, mid, last);
   }
}
```

Method `mergeSort` calls method `merge`, which has the following header.

```
/** Merge a[lb] to a[mi] and a[mi+1] to a[ub].
 *  Precondition: a[lb] to a[mi] and a[mi+1] to a[ub]
both
 *                sorted in increasing order.
 */
private void merge(int lb, int mi, int ub)
```

If the first call to `mergeSort` is `mergeSort(0,3)`, how many *further* calls will there be to `mergeSort` before an array `b[0]…b[3]` is sorted?

(A) 2

(B) 3

(C) 4

(D) 5

(E) 6

36. A large hospital maintains a list of patients' records in no particular orde find the record of a given patient, which represents the most efficient me that will work?

(A) Do a sequential search on the name field of the records.

(B) Do a binary search on the name field of the records.

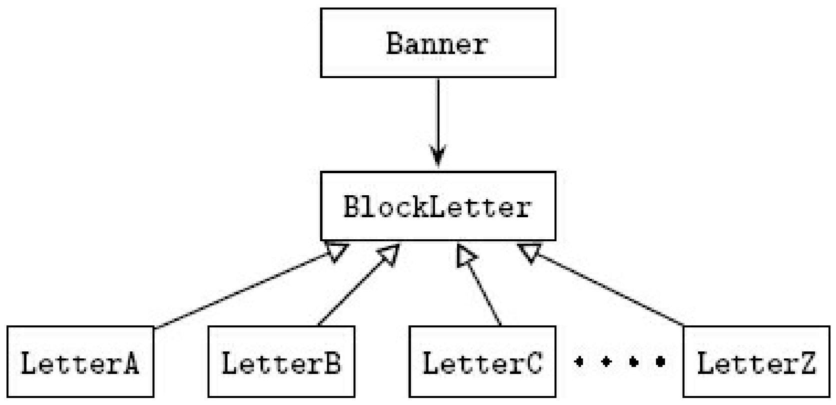
(C) Use insertion sort to sort the records alphabetically by name; then do a sequential search on the name field of the records.

(D) Use merge sort to sort the records alphabetically by name; then do a sequential search on the name field of the records.

(E) Use merge sort to sort the records alphabetically by name; then do a binary search on the name field of the records.

Use the following information for Questions 37 and 38.

Here is a diagram that shows the relationship between some of the classes that will be used in a program to draw a banner with block letters.



The diagram shows that the `Banner` class uses `BlockLetter` objects, and that the `BlockLetter` class has 26 subclasses, representing block letters from A to Z.

The `BlockLetter` class has a `draw` method

```
public void draw()
```

Each of the subclasses shown implements the `draw` method in a unique way to draw its particular letter. The `Banner` class gets an array of `BlockLetter` and has a method to draw all the letters in this array.

Here is a partial implementation of the `Banner` class.

```
public class Banner
{
   private BlockLetter[] letters;
   private int numLetters;

/** Constructor. Gets the letters for the Banner. */
public Banner()
{
   numLetters = < some integer read from user input >
   letters = getLetters();
}

/** Returns an array of block letters. */
public BlockLetter[] getLetters()
{
   String letter;
   letters = new BlockLetter[numLetters];
   for (int i = 0; i < numLetters; i++)
   {
      < read in capital letter >

      if (letter.equals("A"))
          letters[i] = new LetterA();
      else if (letter.equals("B"))
          letters[i] = new LetterB();
            …               //similar code for C through Y
      else
         letters[i] = new LetterZ();
   }
   return letters;
}

/** Draw all the letters in the Banner. */
public void drawLetters()
{
   for (BlockLetter letter : letters)
       letter.draw();
   }
}
```

37. You are given the information that `Banner` and `BlockLetter` are two cl used in the program. Which of the following can you conclude abou classes?

I `BlockLetter` inherits all the methods of `Banner.`

II `Banner` contains at least one `BlockLetter` object.

III Each of the subclasses `LetterA, LetterB, LetterC, … LetterZ` has an overridden `draw` method.

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

38. Which is a true statement about method `drawLetters`?

(A) It is an overloaded method in the `Banner` class.
(B) It is an overridden method in the `Banner` class.
(C) It uses polymorphism to draw the correct letters.
(D) It will cause a logic error because the draw method of the `BlockLetter` class is different from the `draw` methods of its subclasses.
(E) It will cause a run-time error because there is no `draw` method in the `Banner` class.

39. Consider `method1` and `method2` below, which are identical except fo second last line of code. Each method returns a new matrix based on the matrix `mat`.

```
public static int[][] method1(int[][] mat)
{
   int numRows = mat.length;
   int numCols = mat[0].length;
   int[][] newMat = new int[numRows][numCols];
   for (int row = 0; row < numRows; row++)
       for (int col = 0; col < numCols; col++)
           newMat[numRows - row -1][col] = mat[row][col];
   return newMat;
}

public static int[][] method2(int[][] mat)
{
   int numRows = mat.length;
   int numCols = mat[0].length;
   int[][] newMat = new int[numRows][numCols];
   for (int row = 0; row < numRows; row++)
      for (int col = 0; col < numCols; col++)
          newMat[row][col] = mat[numRows - row - 1][col];
   return newMat;
}
```

Suppose the same input matrix is used for `method1` and `method2`, and the output for `method1` is `matrix1` while the output for `method2` is `matrix2`. Which is a true statement about `matrix1` and `matrix2`?

(A) `matrix1` is identical to `matrix2`.

(B) The rows of `matrix1` are the columns of `matrix2`.

(C) `matrix1` is a reflection of `matrix2` across a vertical line on the edge of either matrix.

(D) `matrix1` is a reflection of `matrix2` across a horizontal line on the bottom or top edge of either matrix.

(E) The rows of `matrix1` are the rows of `matrix2` in reverse order.

40. Consider an `ArrayList cards` of `Card` objects that needs to be shuffled. following algorithm is used for shuffling.

```
Create a temporary ArrayList<Card>
Do the following cards.size() number of times
    − Generate a random integer r that can index any card in cards
    − Remove the card found at position r in cards and add it to the
        end of the temporary ArrayList
Set cards to the temporary ArrayList
```

Here is the method that implements this algorithm.

```
Line 1: public void shuffle()
Line 2: {
Line 3:    int size = cards.size();
Line 4:    ArrayList<Card> temp = new ArrayList<Card>();
Line 5:    for (int j = 1; j < size; j++)
Line 6:    {
Line 7:       int index = (int) (Math.random() * size);
Line 8:       temp.add(cards.get(index));
Line 9:    }
Line 10:    cards = temp;
Line 11: }
```

The method does not work as intended. Which of the following changes to `shuffle` would ensure that it works correctly?

I Replace Line 5 with

```
for (int j = 0; j < size; j++)
```

II Replace Line 7 with

```
int index = (int) (Math.random() * cards.size());
```

III Replace Line 8 with

```
temp.add(cards.remove(index));
```

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

END OF SECTION I

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.

Write your answers in pencil only in the booklet provided.

NOTES:

- ■ Assume that the classes in the Quick Reference have been imported where needed.
- ■ 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.
- ■ Inwriting solutions for each question, youmay use any of the accessiblemethods 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. This question uses a password checker to report whether a given passwc weak, medium, or strong. The `PasswordChecker` class is shown below. will write two methods of the `PasswordChecker` class.

```
public class PasswordChecker
{
    /** Returns the number of digits in s.
     *  Precondition: s contains at least one character.
     */
    public static int numDigits(String s)
    { /* implementation not shown */ }

    /** Returns the number of letters in s.
     *  Precondition: s contains at least one character.
     */
    public static int numLetters(String s)
    { /* implementation not shown */ }

    /** Returns the number of characters in s
     *  that are neither letters nor digits.
     *  Precondition: s contains at least one character.
     */
    public static int numSymbols(String s)
    { /* to be implemented in part (a) */ }

    /** Returns the strength of password p
     *    as described in part (b).
     *  Precondition: p contains at least one character.
     */
    public static String passwordStrength(String p)
    { /* to be implemented in part (b) */ }

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

(a) Complete the `numSymbols` method, which finds how many characters in `String s` are neither letters or digits.

Two helper methods, `numDigits` and `numLetters`, have been provided.

- `numDigits` returns the number of digits in its `String` parameter.
- `numLetters` returns the number of letters in its `String` parameter.

The following are some examples showing the use of `numDigits`, `numLetters`, and `numSymbols`.

Method Call	Return Value
`numDigits("R2@n49")`	3

`numLetters("R2@n49")`	2
`numSymbols("R2@n49")`	1
`numDigits("!?!?")`	0
`numLetters("!?!?")`	0
`numSymbols("!?!?")`	4

Complete the `numSymbols` method below. You must use `numDigits` and `numLetters` appropriately to receive full credit.

```
/** Returns the number of characters in s
 *  that are neither letters nor digits.
 *  Precondition: s contains at least one character.
 */
public static int numSymbols(String s)
```

(b) Write the `passwordStrength` method. The method returns one of three `String` values: `"strong"`, `"medium"`, or `"weak"`, depending on the characters of its `String` parameter `p`.

Here are the criteria for each type of password. (Assume that the word “symbol” refers to a character that is neither a digit nor a letter.)

- A strong password is one with at least 8 characters and at least one digit, one letter, and one symbol.
- A medium password has two possibilities:
  - Between 5 and 8 characters (5 inclusive), at least one of which is a symbol.
  - 8 or more characters, but is missing a digit, or letter or symbol, the second condition for being strong.
- A weak password has two possibilities:
  - Fewer than 5 characters
  - Between 5 and 8 characters 5 inclusive, in which none of the characters is a symbol.

Here are some examples.

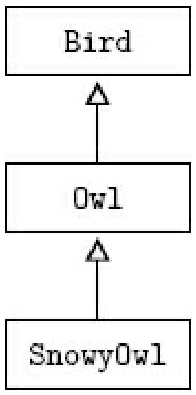
Method Call	**Return Val**
`checkPassword("c@8")`	weak
`checkPassword("c1A2b3")`	

	weak
`checkPassword("c/A2b3")`	medium
`checkPassword("Two4two?")`	strong
`checkPassword("Hot3dog2019")`	medium

Complete method `passwordStrength` below. Assume that `numSymbols` works as specified, regardless of what you wrote in part (a).

```
/** Returns the strength of password p
 *      as described in part (b).
 *  Precondition: p contains at least one character.
 */
public static String passwordStrength(String p)
```

2. In this question, you will write the implementation of a `SnowyOwl` class b
   on the hierarchy of classes shown below.



The `Owl` class is as follows.

```
public class Owl
{
   private String name;

   public Owl()
   { name = ""; }

   public Owl(String owlName)
   { name = owlName; }

   public String getName()
```

```
        { return name; }

        public String getFood()
        { return "furry animals, insects, or small birds"; }
    }
```

Here are some features of a `SnowyOwl`.

- It's an `Owl` whose name is always `"Snowy owl"`.
- If the owl is a male, its color is white.
- If it is a female, its color is speckled.
- Food for a `SnowyOwl` depends on what is available. A `SnowyOwl` will randomly eat a hare, a lemming, or a small bird, where each type of food is equally likely.

The `SnowyOwl` class should have a private instance variable of type boolean that stores `true` if the owl is male, `false` otherwise. It should also have a constructor and a `getColor` method that returns a string with the snowy owl's color.

Write the complete `SnowyOwl` class below. Your implementation should meet all specifications for a `SnowyOwl`.

3. Consider a system for processing names and addresses from a mailing li
`Recipients` class will be used as part of this system. The lines in the ma
list are stored in an `ArrayList<String>`, a private instance variable i
`Recipients` class. The blank line that separates recipients in the mailin
is stored as the empty string in this list, and the final element in the list
empty string.

A portion of the mailing list is shown below, with the corresponding part of the `ArrayList`.

```
Mr. J. Adams
6 Rose St.
Ithaca, NY 14850

Jack S. Smith
12 Posy Way
```

```
Suite 201
Glendale, CA 91203

Ms. M.K. Delgado
2 River Dr.
New York, NY 10013

      …
```

0	1	2	3	4
"Mr. J. Adams"	"6 Rose St."	"Ithaca, NY 14850"	""	"Jack S. Smith"

5	6	7	8	9
"12 Posy Way"	"Suite 201"	"Glendale, CA 91023"	""	"Ms. M.K. Delgado"

10	11	12	
"2 River Dr."	"New York, NY 10013"	""	...

The `Recipients` class that processes this data is shown below.

```
public class Recipients
{
   /** The list of lines in the mailing list */
   private ArrayList<String> lines;

   /** Constructor. Fill lines with mailing list data.
    *  Postcondition:
    *    - Each element in lines is one line of the
mailing list.
    *    - Lines appear in the list in the same order
    *      that they appear in the mailing list.
    *    - Blank line separators in the mailing list are
stored
    *      as empty strings.
    */
   public Recipients()
   { /* implementation not shown */ }

   /** Returns the city contained in the cityZip string
of
```

```
    *  an address, as described in part (a).
    */
   public String extractCity(String cityZip)
   { /* to be implemented in part (a) */ }

   /** Returns the address of the recipient with the
specified
    *  name, as described in part (b).
    */
   public String getAddress(String name)
   {/* to be implemented in part (b) */}

   //Other methods are not shown.
}
```

(a) Write the `extractCity` method of the `Recipients` class. In the `cityZip` parameter the city is followed by a comma, then one blank space, then two capital letters for a state abbreviation, then a space and 5-digit ZIP code. For example, if `cityZip is "Ithaca, NY 14850"`, the method call `extractCity(cityZip)` should return `"Ithaca"`.

Class information for this question

```
public class Recipients

private ArrayList<String> lines
public Recipients()
public String extractCity(String cityZip)
public String getAddress(String name)
```

Complete method `extractCity` below.

```
/** Returns the city contained in the cityZip string of
 *  an address, as described in part (a).
 */
public String extractCity(String cityZip)
```

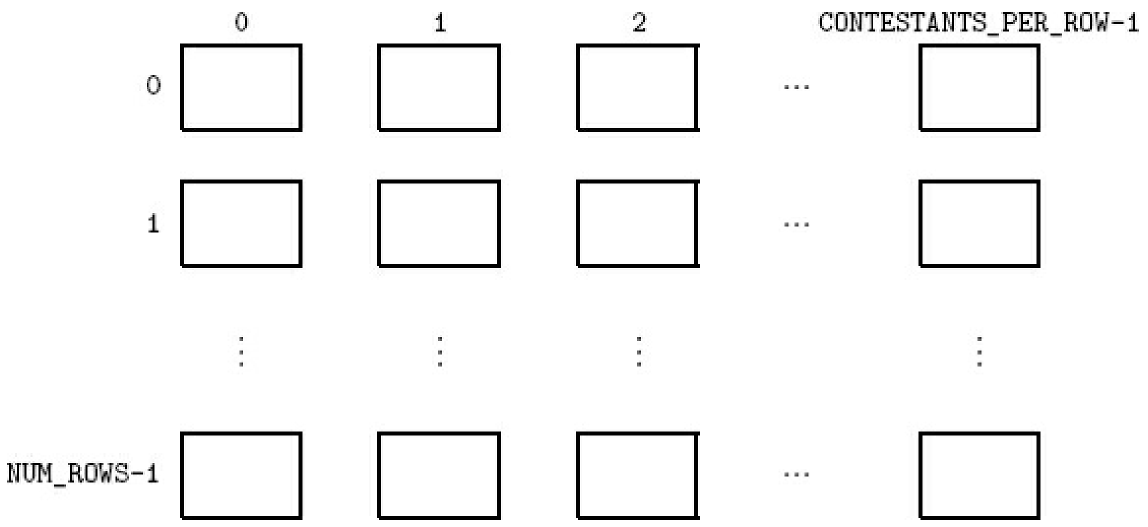
(b) Write the `getAddress` method of the `Recipients` class. This method should return a string that contains only the address of the corresponding `name` parameter. For example, if `name` is `"Jack S. Smith"`, a string containing the three subsequent lines of his address should be returned. This string should contain line breaks in appropriate places, including after the last line of the address. This ensures that the address will have the proper address format when printed by a client class. In the given example of name `"Jack S. Smith"`, the printed version of his address string should look like this:

```
Jack S. Smith
12 Posy Way
Suite 201
Glendale, CA 91203
```

Complete method getAddress below.

```
/** Returns the address of the recipient with the
specified
 *  name, as described in part (b).
 */
public String getAddress(String name)
```

4. A puzzle-solving competition is held in a large hall with a two-dimens arrangement of contestants. Each rectangle below represents one contesta



A contestant in the contest can be represented by a `Contestant` class, whose partial implementation is shown below.

```
public class Contestant
```

```
{
    private String name;
    private int score;

    /** Returns the name of this contestant. */
    public String getName()
    { return name; }

    /** Returns the score of this contestant. */
    public int getScore()
    { return score; }

    //Constructor and other methods are not shown.
}
```

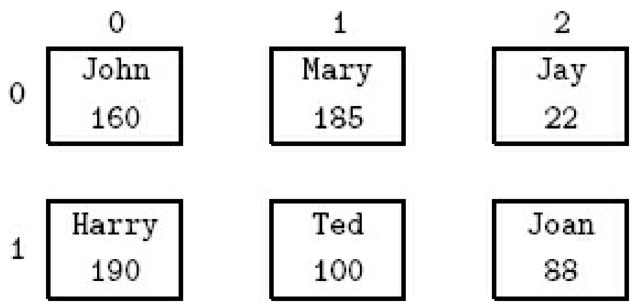
In parts (a) and (b) you will write two methods of a `ContestOrganizer` class, whose partial implementation is shown below. A contest organizer keeps track of contestants in a two-dimensional array.

```
public class ContestOrganizer
{
    /** the number of rows of contestants */
    public static final int NUM_ROWS = < some integer >;

    /** the number of columns of contestants */
    public static final int CONTESTANTS_PER_ROW = < some
integer >;

    /** The two-dimensional array of contestants */
    private Contestant[][] contestants;

    /** Sorts arr in increasing order by score. */
    private void sort(Contestant[] arr)
    { /* implementation not shown */ }

    /** Sorts each row of contestants into increasing
order by score.
    *  Postcondition: Contestant with highest score in
row[k] is
    *                 in the rightmost column of row[k],
0<=k<NUM_ROWS.
    */
    public void sortAllRows()
    { /* to be implemented in part(a) */ }

    /** Returns name of contestant with highest score.
```

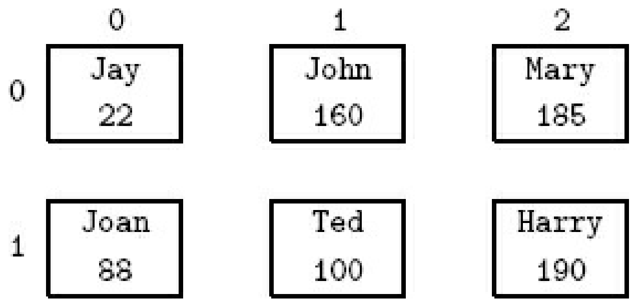
```
      *  **Precondition:**
      *    - Contestants have not been sorted by score.
      *    - Top score is unique.
      *    - Only one contestant has the highest score.
      */
     public String findWinnerName()
     { /* to be implemented in part(b) */ }
 }
```

(a) Write the `ContestOrganizer` method `sortAllRows`. This method should sort the contestants by score in each row, from lowest to highest.

Example: Suppose contestants are as shown below.



Here is what contestants will be after a call to `sortAllRows`.



In writing `sortAllRows`, your method *must* use the `ContestOrganizer` method `sort`. You may assume that `sort` works as specified.

Complete method `sortAllRows` below.

```
/** Sorts each row of contestants into increasing order
```

```
by score.
   *  Postcondition: Contestant with highest score in
row[k] is
   *                 in the rightmost column of row[k],
0<=k<NUM_ROWS.
   */
   public void sortAllRows()
```

(b) Write the `Contestant` method `findWinnerName`, which returns the name of the contestant with the highest score. For example, if the contestants are as shown above, a call to `findWinnerName` should return `"Harry"`.

When writing `findWinnerName`, you should assume that the contestants have not yet been sorted by score, and that there is only one contestant with the highest score. In writing your solution, you *must* use method `sortAllRows`. You may assume that `sortAllRows` works as specified, regardless of what you wrote in part (a).

Complete method `findWinnerName` below.

```
/** Returns name of contestant with highest score.
 *  Precondition:
 *    - Contestants have not been sorted by score.
 *    - Top score is unique.
 *    - Only one contestant has the highest score.
 */
public String findWinnerName()
```

STOP END OF EXAM

ANSWER KEY

Practice Test 1

Section I