0.) THE EASY ONE (1 point total)
Check cover sheet for name, recitation #, PennKey, and signature.

1.) TYPES AND VALUES (9 points total)

Fill in the data type and final value of the variable a. (Assume a has been declared with the appropriate data type.) Write “CE” as the data type if the statements will cause compiler error, or “RE” if they will cause a run-time error. Give the reason for the error in the third column. The first row has been filled in for you.

<table>
<thead>
<tr>
<th></th>
<th>Type of a</th>
<th>Value of a/Error explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>_____ a = 2;</td>
<td>int</td>
<td>2</td>
</tr>
<tr>
<td>_____ a = false;</td>
<td>boolean</td>
<td>true</td>
</tr>
<tr>
<td>a = a</td>
<td></td>
<td>(true &amp;&amp; !false);</td>
</tr>
<tr>
<td>double x = 3;</td>
<td>double</td>
<td>2.0 -or- 2</td>
</tr>
<tr>
<td>x--;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ a = x;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>String x = &quot;oneten&quot;;</td>
<td>RE-- or --CE</td>
<td>‘4’ == 42: out of bounds</td>
</tr>
<tr>
<td>_____ a = x.charAt(‘4’);</td>
<td>-- or --</td>
<td>argument should be int not char</td>
</tr>
<tr>
<td>double x = 4;</td>
<td>compiler error</td>
<td>Use a = Math.pow(x, .5);</td>
</tr>
<tr>
<td>_____ a = x.pow(.5);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>int[] x = { 3, 1, 4, 1 };</td>
<td>int</td>
<td>1</td>
</tr>
<tr>
<td>_____ a = x[x[0]];</td>
<td></td>
<td></td>
</tr>
<tr>
<td>String x = &quot;oneten&quot;;</td>
<td>compiler error</td>
<td>Use a = x.length();</td>
</tr>
<tr>
<td>_____ a = String.length(x);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ a = &quot;i&quot;;</td>
<td>String</td>
<td>&quot;1111&quot; -or- 1111</td>
</tr>
<tr>
<td>a = a + a;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a += a;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ a = 3;</td>
<td>int</td>
<td>1</td>
</tr>
<tr>
<td>a = a / 2;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>int x = 15;</td>
<td>boolean</td>
<td>true</td>
</tr>
<tr>
<td>int y = 2 * x / 2;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ a = x == y;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.) HORTON HIRES A WHO (12 points total)
The Horton School of Funny Business has hired you, a recent CIS 110 graduate, to rewrite its grade calculation software. Your first task is to write a function `computeLetterGrades()` that takes an array of percentage scores (between 0 and 100, rounded to the nearest 10th of a percent), and returns an array of letter grades corresponding to the table below. The function does not need to do any error checking. You may use any of the functions from Java’s `Math` library.

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 49.9</td>
<td>B-</td>
</tr>
<tr>
<td>50 – 59.9</td>
<td>B</td>
</tr>
<tr>
<td>60 – 69.9</td>
<td>B+</td>
</tr>
<tr>
<td>70 – 79.9</td>
<td>A-</td>
</tr>
<tr>
<td>80 – 100</td>
<td>50% chance of A, 50% chance of A+</td>
</tr>
</tbody>
</table>

Fill in the blanks below to complete the `computeLetterGrades()` function:

```java
public static String[] computeLetterGrades(double[] grades) {
    String[] letterGrades = new String[grades.length];
    for (int i = 0; i < grades.length; i++) {
        if (grades[i] < 50) {
            letterGrades[i] = "B-";
        } else if (grades[i] < 60) {
            letterGrades[i] = "B";
        } else if (grades[i] < 70) {
            letterGrades[i] = "B+";
        } else if (grades[i] < 80) {
            letterGrades[i] = "A-";
        } else if (Math.random() < 0.5) {
            letterGrades[i] = "A";
        } else {
            letterGrades[i] = "A+";
        }
    }
    return letterGrades;
}
```
3.) DEBUGGING (10 points total)
Benedict has written a program to fill an array of length $\text{args}[0]$ with random integers from 0 to 9 (including 0 and 9), then print out the average of all even numbers in the array. But as you know from lecture, he is prone to mistakes. Find the 8 buggy lines in his program, and write the line numbers and complete, corrected lines on the next page. (Some lines may have more than one bug, but they still count as a single, buggy line.) To delete a line, write the line number and “Delete line.” To insert a line, write the line numbers on either side of the point where you will insert your code, and write “Add line:” and your line of code. The first buggy line has been corrected for you, so you have 7 more to find.

```java
00: public class EvenAverage
01: public static void main(String[] args) {
02:     int fly = Integer.parseInt(args[0]); // number of array entries
03:     int[] tic; // array for random numbers
04:
05:     // fill in random numbers
06:     for (int gnat = 0; gnat < fly; gnat++) {
07:         tic[gnat] = (int) (10 * Math.random());
08:         gnat = gnat + 1;
09:     }
10:
11:     int louse = 0; // loop index for inspecting values
12:     int spider = 0; // sum of even values
13:     int centipede = 0; // number of even values
14:
15:     // find sum of even values and number of even values
16:     while (louse < fly) {
17:         if tic[louse] % 2 == 0 {
18:             spider += tic[louse];
19:             centipede++;
20:         }
21:     }
22:
23:     System.out.println("Average of even numbers = " +
24:         spider / (double) centipede);
25: }
26: }

Bug 0: Line 00: public class EvenAverage {
Bug 1: Line 03: int[] tic = new int[fly];
Bug 2: Line 06: for (int gnat = 0; gnat < fly; gnat++) {
Bug 4: Line 08: Delete line.
Bug 5: Line 17: if (tic[louse] % 2 == 0) {
Bug 6: 20-21: Insert line: louse++;
Bug 7: Line 24: spider / (double) centipede);
```
4.) ALEXANDER THE GREAT (16 points total)
Your friendly TAs Alex Brashear, Alex Kornhauser, and Alex Whitaker were recently working on a class project together. Each TA wrote one function, which he named after himself. The program works, but we’re having trouble figuring out what it does. Trace through the program and record the values of a, b, and c in the order that each comment of the form /* LINE XX */ is reached. Assume the program is run with the arguments 1 1. Write your answers on the following page. The first one has been filled in for you.

```java
public class ProjectAlexander {
    public static int alex(boolean c, int a, double b) {
        c = c || (a >= b);
        /* LINE 4 */
        a = alex(a * 2, !c, b * 4);
        /* LINE 6 */
        c = a > b;
        /* LINE 8 */
        b = alex(a * 3, b * 5, !c);
        /* LINE 10 */
        c = !c;
        /* LINE 12 */
        return (int) (b / a);
    }

    public static int alex(int a, boolean c, double b) {
        /* LINE 17 */
        return (int) b + a;
    }

    public static int alex(int a, double b, boolean c) {
        /* LINE 22 */
        return (int) b - a;
    }

    public static void main(String[] args) {
        int a = Integer.parseInt(args[0]);
        double b = Double.parseDouble(args[1]);
        boolean c = false;
        /* LINE 30 */
        a = alex(c, a, b);
        /* LINE 32 */
    }
}
```

1: Line 4: a = 1, b = 1.0, c = true
2: Line 17: a = 2, b = 4.0, c = false
3: Line 6: a = 6, b = 1.0, c = true
4: Line 8: a = 6, b = 1.0, c = true
5: Line 22: a = 18, b = 5.0, c = false
6: Line 10: a = 6, b = -13.0, c = true
7: Line 12: a = 6, b = -13.0, c = false
8: Line 32: a = -2, b = 1.0, c = false
5.) CODING  (20 points total)

For the two code writing questions below, write only the functions. Do not write the class statement. You are welcome to write comments, but it is not required. You may use any of the Math functions (Math.sqrt(), Math.min(), Math.abs(), etc.) and any of the string functions (s.equals(), s.compareTo(), etc.).

5.1) (10 points) Write a function sameSign() that takes an array of integers and returns true if they are all greater than zero or all less than zero, and false otherwise. If the array is null or empty, return true.

```java
public static boolean sameSign(int[] arr) {
    if (arr == null) return true;
    for (int i = 0; i < arr.length; i++)
        if (arr[0] * arr[i] <= 0) return false;
    return true;
}
-- or --
public static boolean sameSign(int[] arr) {
    if (arr == null) return true;
    if (arr.length == 0) return true;
    if (arr[0] < 0) {
        for (int i = 1; i < arr.length; i++)
            if (arr[i] >= 0) return false;
    } else {
        for (int i = 0; i < arr.length; i++)
            if (arr[i] <= 0) return false;
    }
    return true;
}
-- or --
public static boolean sameSign(int[] arr) {
    if (arr == null || arr.length == 0) return true;
    int pos = 0, neg = 0;
    for (int i = 0; i < arr.length; i++) {
        if (arr[i] > 0) pos++;
        if (arr[i] < 0) neg++;
    }
    return (pos == a.length || neg == a.length);
}
```

5.2) (10 points) Write a function isSorted() that uses sameSign() to take an array of strings and returns true if they are sorted in alphabetical or reverse alphabetical order and every string is different. Use the compareTo() function to determine “alphabetical order.” Otherwise return false.
public static boolean isSorted(String[] arr) {
    if (arr == null) return true;
    if (arr.length == 0) return true;

    int[] sorted = new int[arr.length - 1];
    for (int i = 0; i < sorted.length; i++)
        sorted[i] = arr[i].compareTo(arr[i + 1]);

    return sameSign(sorted);
}
6.) TWENTY QUESTIONS  (5 points total)
Your friend tells you she has thought of a number between 1 and 400. You would like to guess this
number in the least number of tries. Each time you guess a number your friend says 'too high', 'too
low' or tells you that you have the right number.

6.1) (2 points) If you play this guessing game correctly then, regardless of the number your friend
chooses, you can find it in less than N guesses. What is the smallest possible value of N?
   (a) 200
   (b) 400
   (c) **10**
   (d) 9
   (e) 8

6.2) (2 points) In **thirty words or less**, explain how you will always find your friend’s number in
this many guesses.
Try 200. Then 100 or 300, and so on until only one number remains.

6.3) (1 point) What is the name of the algorithm you used?  **binary search**