Name: _____

Write all of your responses on these exam pages. If you need extra space please use the backs of the pages.

1 Short Answer (15 Points Each)

1. Write the following Java declarations,

   (a) A double named p that is initialized with the value of π.

   (b) A string that is initialized to your name.

   (c) A two-dimensional array of integers with 21 rows and 52 columns.

   (d) A one-dimensional array of strings of size 100.

   (e) An array list of doubles.

2. Answer the following questions about numeric data types in Java.

   (a) What happens when you overload an int?

   (b) What happens when you overload a double?

   (c) What happens when you underload an int?

   (d) What happens when you underload a double?

   (e) What happens when you input an integer when the Scanner is doing a nextDouble?

3. Write a method that will simulate the rolling of five dice and stop when all five dice have the same value. The method is to count the number of rolls it takes to get all five dice to have the same value and return that count.

4. Write a method called `IncomeTax` that will take as input a decimal number representing the user's yearly taxable income and return the amount of income tax they must pay the government. Income tax is calculated as a percentage of the users income according to what bracket they fall in. Here is the tax scheme. If the person makes less than \$40,000 they pay 20% of their income in tax. If the person makes \$40,000 or more up to but not including \$60,000 they pay \$8,000 plus 25% of their income that exceeds \$40,000 in tax, that is, if they make \$50,000 they pay \$8,000 plus 25% of \$10,000. If the person makes \$60,000 or more up to but not including \$100,000 they pay \$13,000 plus 27.5% of their income that exceeds \$60,000 in tax. If the person makes \$100,000 or more they pay \$24,000 plus 30% of their income that exceeds \$100,000 in tax.

5. Write a method called `RemoveLast` that takes as input two strings, `str1` and `str2`, and returns a string that is `str1` with the last occurrence of `str2` removed. For example, if `str1` is the string

   `this␣is␣a␣string␣for␣this␣problem␣on␣this␣exam.`

   and `str2` is the string `this` then the returned string will be

   `this␣is␣a␣string␣for␣this␣problem␣on␣exam.`

6. Write a method that sorts an array of integers using either the bubble sort, selection sort, or insertion sort. You must state which sort you are writing.

7. Write a method that will take as input a single parameter of a two-dimensional array of integers and return a one-dimensional of doubles which holds the column averages of the two-dimensional array.

8. Write a method that will take as input a single parameter of an array list integers and return another array list of integers that holds the minimum and maximum values from the input list.

2 Program Traces (20 Points Each)

1. Determine the outputs for each of the following inputs.

```
1  import java.util.Scanner;
2
3  public class FinalTrace1 {
4
5      public static void Print(int[] C) {
6          for (int i = 0; i < C.length; i++)
7              System.out.print(C[i] + " ");
8          System.out.println();
9      }
10
11     public static void DoMore(int[] B) {
12         for (int i = 0; i < B.length; i++)
13             if (B[i] % 2 == 0)
14                 B[i / 2] = B[i];
15     }
16
17     public static void Do(int[] A, int n) {
18         if (n > 2) {
19             for (int i = 0; i < A.length; i++)
20                 A[i] = A[(n * i) % A.length];
21         } else {
22             for (int i = 0; i < A.length / 2; i
                   ++)
23                 A[i] = A[A.length - 1 - i];
24         }
25         n = 2 * n;
26     }
27
28     public static void main(String[] args) {
29         Scanner kb = new Scanner(System.in);
30         System.out.print("Input: ");
31         int n = kb.nextInt();
32         int[] B = new int[n];
33
34         for (int i = 0; i < B.length; i++)
35             B[i] = kb.nextInt();
36
37         n = kb.nextInt();
38         Print(B);
39         System.out.println("---");
40         int[] C = B;
41         Do(C, n);
42         Print(B);
43         Print(C);
44         System.out.println("---");
45         DoMore(B);
46         Print(B);
47         Print(C);
48         System.out.println("---");
49         C = new int[B.length];
50         for (int i = 0; i < B.length; i++)
51             C[i] = (5 * B[i]) / n;
52         Do(C, n);
53         Print(B);
54         Print(C);
55     }
56 }
```

(a) `Input: 5 3 2 4 7 6 2`

(b) `Input: 7 3 6 4 -2 0 8 1 2`

2. Determine the outputs for each of the following inputs.

```java
import java.util.Scanner;

public class FinalTrace2 {

    public static int Method1(int a, int b) {
        while (a > b) {
            a -= b;
        }

        System.out.println(a + " " + b);

        if (a > 5) {
            int temp = a;
            a = b;
            b = temp;
            System.out.println("A");
        } else {
            a = a + b;
            System.out.println("B");
        }

        System.out.println(a + " " + b);

        return a - b;
    }

    public static int Method2(int a, int b) {
        int c = a / b;
        while (c < a) {
            a++;
            --b;
            c += 2;
            System.out.print("C");
        }
        System.out.println();
        return a + b + c;
    }

    public static int Method3(int a, int b) {
        int c = 0;
        for (int i = a; i < b; i++) {
            c++;
            if (c > 4) {
                c = 0;
                b++;
            }
        }
        return c;
    }

    public static void main(String[] args) {
        Scanner kb = new Scanner(System.in);
        System.out.print("Input: ");
        int n = kb.nextInt();
        int m = kb.nextInt();
        int k = kb.nextInt();
        System.out.println(Method1(n, m));
        System.out.println(Method2(m, k));
        int t = Method1(k, n);
        int r = Method2(n, k);
        System.out.println(Method3(t, r));
    }
}
```

(a) `Input: 2 4 7`

(b) `Input: 9 6 8`

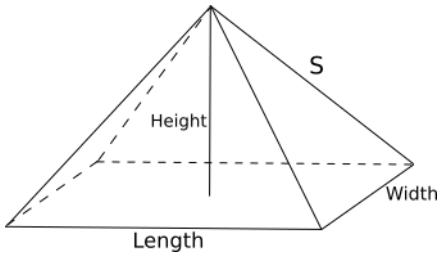
3 Coding (25 Points Each)

1. Create a `Pyramid` class class that stores three double values for the length of the base, the width of the base, and the height of the pyramid. The class is to have a single constructor that loads in the length, width, and height into the object. The class is to have three more methods,

   - `Volume` — This returns the volume of the pyramid. The volume of a pyramid is $\frac{1}{3}$ the area of the base times the height.
   - `SurfaceArea` — This returns the surface area of the pyramid. The surface area of a pyramid is the sum of the areas of the 5 faces. That is, the rectangular base and the four triangles. Recall that the area of a triangle can be found using Heron's formula. If the lengths of the sides of a triangle are a, b, and c then the area of the triangle is $A = \sqrt{p(p-a)(p-b)(p-c)}$, where p is the semi-perimeter, that is, $p = \frac{a+b+c}{2}$.
   - `EdgeLength` — This returns the edge length of the pyramid. Which is the sum of the lengths of the 8 edges of the pyramid.

   To do these calculations, you will need the length of the side s in the picture below. The length s is called the slant height of the pyramid. If L, W, and H are the length, width, and height of the pyramid then the slant height is, $s = \sqrt{H^2 + \left(\frac{L}{2}\right)^2 + \left(\frac{W}{2}\right)^2}$.

   Also write a main program that creates a pyramid with length 5, width 3 and height 7, then prints out the volume, surface area, and edge length.



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2. Write a program that will take one input integer from the user, n. The program will then generate the $3n+1$ sequence and store the sequence in an array list. Recall that the $3n+1$ sequence is defined as a list of numbers that starts with a positive integer larger than 1. Each number in the sequence is determined by the previous number. If the previous number is even then the next number is the previous divided by 2. If the previous number is odd then the next number is the previous times 3 and add one. We stop when the last number is 1. The program will then output the number of integers in the list and then print out the array list that holds the numbers. An example run is below.

```
Input an integer: 7
Number of integers in list = 17
7 22 11 34 17 52 26 13 40 20 10 5 16 8 4 2 1
```

Some things to think about and some methods you need to write,

(a) Create a method PrintArrayList that takes in a single untyped array list as its only parameter and prints its contents to the screen with a single space between the entries. The main will call this method at the end to print the array list.

(b) Create a method called NextNunber that will take in a single integer parameter and return the next number in the $3n+1$ sequence. So an input of 7 will give an output of 22, an input of 52 will return 26, and so on. This method will be called from the PopulateArray method.

(c) Create a method called PopulateArray that takes in two parameters, an array list of integers and a starting integer of the sequence. This method will use the NextNunber method to store the sequence in the array list.
