Functions Gone Wild 2025

<u>This problem will be worth 16 points</u>. Each successfully implemented function will earn you a point. There is the student tester and one test for each of the 10 functions for a total of 11 possible points. Additional bonus points will be awarded for correctly implementing functions 1-3, functions 4 - 6, functions 7 and 8, and functions 9 and 10. A final bonus point will be awarded for correctly implementing all 10 functions.

This problem will ask you to implement the following functions. One function is defined recursively. On some problems I will give you functions from the java.lang.Math class with a brief description, and sometimes you just need to implement the function. In all the following functions you do **<u>NOT</u>** need worry about domain issues. That is, you may assume that all test data will not cause any exceptions to be thrown. In total, there are ten different functions in this problem. All methods which return a `double` must return a value 'close enough' (less than some delta > 0) to the correct answer to be considered correct.

You should use:

• `Math.max(a,b)` for max(a, b).	• `Math.min(a, b)` for min(a, b)
• `Math.abs(x)` for |x|.	• `Math.cos(a)` for cos(a)
• `Math.sqrt(x)` for $\sqrt{x}$	• `Math.sin(a)` for sin(a)
• `Math.pow(x, 1.0/n)` for $\sqrt[n]{x}$	• `Math.tan(a)` for tan(a)
• `Math.log(a)` for $\ln(a)$	• `Math.log10(a)` for $\log_{10}(a)$ or $\log(a)$
• `Math.ceil(a)` for $\lceil a \rceil$.	• `Math.floor(a)` for $\lfloor a \rfloor$.

note:

- All trig functions are in radians.
- `Math.abs(int a)` returns an `int` and `Math.abs(double a)` returns a `double`
- `Math.max(int a, int b)` and `Math.min(int a, int b)` returns an `int`.
- `Math.max(double a, double b)` and `Math.min(double a, double b)` returns a `double`.
- Return type of all other methods is double.
- $\lfloor x \rfloor$ is the largest (Closes to positive infinity) double value smaller than or equal to the argument, `x`, and is equal to a mathematical integer. For example, $\lfloor 2.9 \rfloor = 2.0$ and $\lfloor -14.3 \rfloor = -15.0$.
- $\lceil x \rceil$ is the smallest (Closes to negative infinity) double value that is greater than or equal to the argument, `x`, and is equal to a mathematical integer. For example, $\lceil 1.1 \rceil$=2.0 and $\lceil -24.9 \rceil = -24$.

- Use the following constant for pi (π)

`Math.PI`	The `double` value that is closer than any other to *pi*, the ratio of the circumference of a circle to its diameter.

- Use the following constant for e

`Math.E`	The `double` value that is closer than any other to *e*, the base of the natural logarithms.

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1.

```
/*
   Here is the first part of the sequence.
     112123123412345

  Here's the same sequence with spaces
     1 12 123 1234 12345

  Note that the first digit of the sequence is 1, the second digit is a 1, …
  There is no 0th digit

  For long sequence, A follows 9, and after Z, start over with lower case letters

  The very last element in the sequence is: 123456789ABC... XYZabc...xyz

  The last digit is the digit at: 1 + 2 + 3 ... + 61 = (61*62)/2 = 1891

  Return the digit at index indicated by the parameter index

*/
```

Use following function heading:

```
     public static String f1(int index)

Test data:  f1(1) returns "1"
            f1(15) returns "5"
            f1(55) returns "A"
            f1(1891) returns "z"
```

2. This problem was asked by Google.

```
/*
   Suppose a list of listSize positive integers ( > 0) has a mean and median
   equal to medianMean.

   What is the largest possible value the list can contain?

*/
```

Use following function heading:

```
     public static int f2(int listSize, int medianMean)

Test data:  f2(8, 44) returns 173
            f2(7, 20) returns 77
            f2(13, 44) returns 302
```

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3.

```
/*
  The sum of three numbers (int) taken in pairs is m, n, and p.

  What is the middle number of the three numbers?

*/
```

Use following function heading:

```
     public static int f3(int m, int n, int p)
```

```
Test data:  f3(12, 17, 19) returns 7
            f3(38, 26, 33) returns 15
            f3(18, -1, 15) returns 1
            f3(-2, -5, -7) returns -2
```

4.

```
/*
   Determine if the values in nums[0], nums[1], and nums[2] are the first
                three ints of an arithmetic sequence in the given order

   If the three ints determine an arithmetic sequence,
       return an int[] containing the next three values
              in the arithmetic sequence in order
   else, return a new int[] with the same values in nums[] in the same order
*/
```

Note: the `int[]` being return must be different than the parameter `nums`, i.e., `f4(nums) != nums`.

Use following function heading:

```
     public static int[] f4(int[] nums)
```

```
Test data:  f4(new int[]{8, 13, 18})   returns new int[]{23, 28, 33}
Test data:  f4(new int[]{-13, -5, 3})  returns new int[]{11, 19, 27}
Test data:  f4(new int[]{-13, 3, -5})  returns new int[]{-13, 3, -5}
Test data:  f4(new int[]{8, 10, 11})   returns new int[]{8, 10, 11 }
```

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5. Implement the following (integer) function

Consider the mathematical notation $\sum_{i=m}^{n}(someFunction)$ used to represent the summation of many similar terms. The notation $\sum_{i=m}^{n}(h(i))$ is defined as: $h(m)+h(m+1)+h(m+2)+\ldots+h(n)$
The subscript gives the symbol for an index variable, i. Here, i represents the index of summation; m is the lower bound of summation, and n is the upper bound of summation. In this case, i = m under the summation symbol means that the index i starts <u>equal</u> to m. Successive values of i are found by adding 1 to the previous value of i, continuing up to and including when i <u>equals</u> n. An example: $\sum_{k=2}^{6} k^2 = 2^2+3^2+4^2+5^2+6^2 = 90$.

Your task in this problem is to implement the following function.

Note – all calculations are to be completed using integer math

Assume:

$start = max\left((int)2\left(\pi^{\left(\frac{e}{2}\right)}\right)sin(3a),\ (int)\ e\left[cos\left(4a-\frac{\pi}{5}\right)\right]\right)$ *and*
$finish = min\ (\mathrm{a}(5+\mathrm{b})-\mathrm{c}, c(7b-3c)+3a)$

$$f4(a,b,c) = \sum_{i=start}^{finish} 2(\mathrm{a}+\mathrm{i})(\mathrm{i}^2-\mathrm{i})+|\mathrm{bi}-2\mathrm{c}|-\frac{\mathrm{i}^2}{5+\mathrm{a}}+\max\left(\mathrm{a}^{\min(|\mathrm{c}|,\mathrm{i}-\mathrm{start})},\max(|\mathrm{a}-6\mathrm{i}|,|-\mathrm{b}(2-\mathrm{i})|)\right)$$

This is equivalent to the following:
remember:

$start = max\left((int)2\left(\pi^{\left(\frac{e}{2}\right)}\right)sin(3a),\ (int)\ e\left[cos\left(4a-\frac{\pi}{5}\right)\right]\right)$ *and*
$finish = min\ (a(5+b)-\mathrm{c}, c(7b-3c)+3a)$

$$2(\mathrm{a}+\mathrm{start})(\mathrm{start}^2-\mathrm{start})+|b*start-2c|-\frac{start^2}{5+a}+ max\left(a^{min(|c|,start-start)},|a-6*start|,|-b(2-start)|\right)$$

+

$$2\big(\mathrm{a}+(\mathrm{start}+1)\big)\big((\mathrm{start}+1)^2-(\mathrm{start}+1)\big)+|b*(\mathrm{start}+1)-2c|-\frac{(\mathrm{start}+1)^2}{5+a}+ max\left(a^{min(|c|,(\mathrm{start}+1)-start)},|a-6*(\mathrm{start}+1)|,\big|-b\big(2-(\mathrm{start}+1)\big)\big|\right)$$

+

$$2\big(\mathrm{a}+(\mathrm{start}+2)\big)\big((\mathrm{start}+2)^2-(\mathrm{start}+2)\big)+|b*(\mathrm{start}+2)-2c|-\frac{(\mathrm{start}+2)^2}{5+a}+ max\left(a^{min(|c|,(\mathrm{start}+2)-start)},|a-6*(\mathrm{start}+2)|,\big|-b\big(2-(\mathrm{start}+2)\big)\big|\right)$$

+.....+

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$$2(\text{a} + \text{finish})(\text{finish}^2 - \text{finish}) + |b * \text{finish} - 2c| - \frac{\text{finish}^2}{5 + a} + max\left(a^{min(|c|,\text{finish}-start)}, |a - 6 * \text{finish}|, |-b(2 - \text{finish})|\right)$$

Special Note: $start > finish$, return 0.

Use following function heading:

```
     public static int f5(int a, int b, int c)
```

```
Test data:
   f5(19, 2, 7)
        returns = f(4) + f(5) + f(6) + f(7) + f(8)
                = 563  + 982  + 1862 + 9041 + 133345 = 145793

   f5(13, 11, 26)
        returns = f(9) + f(10) + f(11) + f(12) + f(13)
                = 3288 + 4281  + 5512  + 8869  + 36755 = 58705

   f5(1, 6, 8)
        returns = f(1) + f(2) + f(3)
                =  16  +  27  +  66  = 109
```

6.

```
/*
   nums.length == 5
   sum(nums) > 0

   Given five integers with a sum greater than 0. Select the first
   negative number, change its sign making it positive and subtract that
   value from the neighboring values
   (assume it wraps around so the first and last value are neighbors).

For example, given:     2, 4, -3, 1, -3
    first iteration:    2, 1, 3, -2, -3
    second iteration:   2, 1, 1,  2, -5
    third iteration:   -3, 1, 1, -3,  5
    ....
How many iterations before all numbers are non negative (>= 0)?
*/
```

Use following function heading:

```
     public static String f6(int[] nums)
```

```
Test data:  f6(new int[] { 2, 4, -3, 1, -3 })  returns 20
```

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7. Implement the following function

$$f7(a) = \begin{cases} \left(a + \sqrt{\pi}\right)^{\pi ln(1+|a|)+e} & log(|cos(a)|) > ln|sin(a)| \\ \sqrt{\left(cos(a) + sin(a)\right)^2 + \left|log\left|\left(tan\left(\frac{a}{3}\right)\right)\right|\right|} & log(|cos(a)|) \leq ln|sin(a)| \end{cases}$$

You may assume all input values will be in the domain of the given functions.
Use following function heading:

```
public static double f7(double a)
```

```
Test data:  f7(1.0)  returns 1.539448989962169
            F7(5.0)  returns 1.2136561333521323
```

8 Implement the following function

If the String contains:

- All letters woefulchripy in any order (upper or lower case), return `woefulchripy`
- All letters woeful in any order (upper or lower case) and not all the letters chirpy, return `woeful`
- All letters chripy in any order (upper or lower case) and not all the letters woeful, return `chripy`
- Otherwise, return `content`

Use following function heading:

```
public static String  f8(String str)
```

```
Test data:   f8("cHIrp Y") returns "chripy"
             f8("lufeow") returns "woeful"
             f8("YlUCfpIheOWr"}) returns "woefulchripy"
             f8("YlUCfphOWr"}) returns "content"
             f8("chirpywoful"}) returns "chripy"
             f8("hirpywoeful"}) returns "woeful"
```

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9. Implement the following function

$$f9(x,y,z) = \begin{cases} true & x = false & y = false & z = false \\ true & x = false & y = false & z = true \\ false & x = false & y = true & z = false \\ true & x = false & y = true & z = true \\ false & x = true & y = false & z = false \\ true & x = true & y = false & z = true \\ true & x = true & y = true & z = false \\ false & x = true & y = true & z = true \end{cases}$$

Use following function heading:

```
public static boolean f9(boolean x, boolean y, boolean z)
```

```
Test data:  f9(false, false, false) returns true
```

10. Implement the following function

$$f10(x,y,z) = \begin{cases} true & j = false & k = false & m = false & n = false \\ false & j = false & k = false & m = false & n = true \\ false & j = false & k = false & m = true & n = false \\ true & j = false & k = false & m = true & n = true \\ false & j = false & k = true & m = false & n = false \\ true & j = false & k = true & m = false & n = true \\ false & j = false & k = true & m = true & n = false \\ true & j = false & k = true & m = true & n = true \\ false & j = true & k = false & m = false & n = false \\ false & j = true & k = false & m = false & n = true \\ true & j = true & k = false & m = true & n = false \\ false & j = true & k = false & m = true & n = true \\ true & j = true & k = true & m = false & n = false \\ true & j = true & k = true & m = false & n = true \\ false & j = true & k = true & m = true & n = false \\ true & j = true & k = true & m = true & n = true \end{cases}$$

Use following function heading:

```
public static boolean f10(boolean j, boolean k, boolean m, boolean n)
```

```
Test data:  f10(false, false, false, false) returns true
```

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