Programming Assignment № 1

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Problem 1

Write a Python function, $\mathrm{is\_multiple}(n, m)$, that takes two integer values and return `True` if n is multiple of m, that is, $n = mi$ for some integer i, and `False` otherwise.

Problem 2

Write a Python function, $\mathrm{is\_even}(k)$, that takes an integer value and return `True` if k is even, and `False` otherwise. However, your function cannot use the muliplication, modulo, or division operators.

Problem 3

Python allows negative integers to be used as indices into a sequence, such as string. If string s has length n, and expression $s[k]$ is used for index $-n \leq k \leq 0$, what is the equivalent index $j \geq$ such that $s[j]$ references the same element?

Problem 4

Write a program that takes two arrays(list) a and b of length n storing int values, return the dot product of a and b. That is, it returns an array(list) c of length n such that $c[i] = a[i] \cdot b[i]$, for $i = 0, 1, \cdots, n-1$.

Problem 5

Explain the difference between mutable objects and immutable objects and give some examples.

Problem 6

Write a function called `convert_pound` that converts pounds to kilograms. One pound is equal to 0.454 kilograms.

Problem 7

Explain why we use a module in software development and how to structure a module in Python.

Problem 8

Consider the following statement, which creates a list of populations of countries in eastern Asia (China, DPR Korea, Hong Kong, Mongolia, Republic of Korea, Japan and Taiwan), in millions: country $populations = [1500, 33, 7, 45, 49, 101, 21]$. Write a function to compute the population average of those countries.

Problem 9

Suppose the file `alkaline_metals.txt` contains this:

```
4 9.012
12 24.305
20 20.078
38 87.62
56 137.327
88 226
```

Write a for loop to read the contents of `alkaline_metals.txt`, and store it in a nested list with each element of the list contains the atomic number and atomic weight for an element(Hint: use $string.split()$).

Problem 10

Design and implement a program that

step 1 asks the user for a temperature in Fahrenheit degrees and reads the number

step 2 computes the correspodning temperature in Celsius degrees

step 3 prints out the temperature in the Celsius scale.

Problem 11

Modify your solution of Problem 10 such that the Fahrenheit temperature is read from the command line.

Problem 12

Some object is moving along a path in the plane. At n points of time we have recorded the corresponding (x, y) positions of the object: $(x_0, y_0), (x_1, y_2), \cdots, (x_{n-1}, y_{n-1})$. The total length L of the path from (x_0, y_0) to (x_{n-1}, y_{n-1}) is the sum of all the individual line segments $((x_{i-1}, y_{i-1})$ to $(x_i, y_i),\ i = 1, \cdots, n-1)$:

$$L = \sum_{i=1}^{n-1} \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}$$

Make a function `pathlength(x, y)` for computing L according to the formula. The arguments x and y hold all the $x_0, \cdots, x_{n-1}$ and $y_0, \cdots, y_{n-1}$ coordinates, respectively. Test the function on a triangular path with the four points $(1, 1), (2, 1), (1, 2)$, and $(1, 1)$.

Problem 13

The value of π equals the circumference of a circle with radius $1/2$. Suppose we approximate the circumference by a polygon through $N + 1$ points on the circle. The length of this polygon can be found using the pathlength function from the above exercise. Compute $N + 1$ points (x_i, y_i) along a circle with radius $1/2$ according to the formulas

$$x_i = \frac{1}{2}\cos(2\pi i/N),\ y_i = \frac{1}{2}\sin(2\pi i/N),\ i = 0, \cdots, N.$$

Call the `pathlength` function and write out the error in the approximation of π for $N = 2k, k = 2, 3, \cdots, 10$.

Problem 14

Make six conversion functions between temperatures in Celsius, Kelvin, and Fahrenheit:

```
C2F(degree)
F2C(degree)
C2K(degree)
K2C(degree)
F2K(degree)
K2F(degree)
```

Collect these functions in a module `convert_temp`. Make some sample calls to the functions from an interactive Python shell.

Problem 15

Extend the module built in Problem 14 with a main program in the test block. This main program should read the first command- line argument as a numerical value of a temperature

and the second argument as a temperature scale: $\mathbf{C}, \mathbf{K}, \mathbf{F}$. Write out the temperature in the other two scales. For example, if $\mathbf{21.3\ C}$ is given on the command line, the output should be $\mathbf{70.34\ F\ 294.45\ K}$.

Problem 16

Write a program that counts words, delimiters, and lines for any paragraph in English.

Problem 17

(Simulate operations on lists by hands) You are given the following program:

```
1  a = [ 1, 3, 5, 7, 9]
2  b = [ 13, 17]
3  c = a + b
4  print(c)
5  b[0] = -1
6  d = [ e + 1 for e in a ]
7  print(d)
8  d.append(b[0]+1)
9  d.append(b[-1] + 1)
10 print(d[:-2])
```

Explain what is printed by each `print` statement.

Problem 18

We define the following nested list:

```
1  q = [['a','b','c'],['d','e','f'],['g','j']]
```

Index this list to extract 1) letter `'a'`; 2) the list `['d','e','f']`; 3) the last element `'h'`; 4) the `'d'` element. Explain why `q[-1][-2]` has the value `'g'`. Code and test your program.

Problem 19

Consider the list from Problem 18. We can visit all elements of q using this instead `for` loop:

```
1  for i in q:
2     for j in range(len(i)):
3        print(i[j])
```

What type of objects are `i` and `j`?

Problem 20

Rewrite the generation of the nested list `q`,

```
q = [r**2 for r in [10**i for i in range(5)]]
```

by using standard `for` loops instead of list comprehensions.