Homework: C Loops

This document defines the homework assignments from [the "C Programming" Course @ Software University]. Please submit as homework a single **`zip`** / **`rar`** / **`7z`** archive holding the solutions (source code) of all below described problems.

Problem 1. Numbers from 1 to N

Write a program that enters from the console a positive integer **n** and **prints all the numbers from 1 to n**, on a single line, separated by a space. Examples:

n	output
3	1 2 3
5	1 2 3 4 5

Problem 2. Numbers Not Divisible by 3 and 7

Write a program that enters from the console a positive integer **n** and prints all the **numbers from 1 to n not divisible by 3 and 7**, on a single line, separated by a space. Examples:

n	output
3	1 2
10	1 2 4 5 8 10

Problem 3. Min, Max, Sum and Average of N Numbers

Write a program that reads from the console a sequence of **n** integer numbers and returns the **minimal**, the **maximal** number, the sum and the average of all numbers (displayed with 2 digits after the decimal point). The **input** starts by the number **n** (alone in a line) followed by **n lines**, each holding an integer number. The **output** is like in the examples below. Examples:

input	output
3 2 5 1	min = 1.00 max = 5.00 sum = 8.00 avg = 2.67

input	output
2 -1 4	min = -1.00 max = 4.00 sum = 3.00 avg = 1.50

Problem 4. Print a Deck of 52 Cards

Write a program that generates and prints **all possible cards from a [standard deck of 52 cards]** (without the jokers). The cards should be printed using the classical notation (like 5S (♠), AH (♥), 9C (♣) and KD (♦)). The card faces should start from 2 to A. Print each card face in its four possible suits: clubs, diamonds, hearts and spades. Use 2 nested **`for`**-loops and a **`switch-case`** statement.

output
2C 2D 2H 2S 3C 3D 3H 3S … KC KD KH KS

```
AC AD AH AS
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Problem 5. Calculate 1 + 1!/X + 2!/X² + … + N!/X^N

Write a program that, for a given two integer numbers **n** and **x**, calculates the sum S = 1 + 1!/x + 2!/x² + … + n!/x^n. Use only one loop. Print the result with 5 digits after the decimal point.

n	x	S
3	2	2.75000
4	3	2.07407
5	-4	0.75781

Problem 6. Calculate N! / K!

Write a program that calculates **n! / k!** for given **n** and **k** (1 < **k** < **n** < 100). Use only one loop. Examples:

n	k	n! / k!
5	2	60
6	5	6
8	3	6720

Problem 7. Calculate N! / (K! * (N-K)!)

In combinatorics, the number of ways to choose **k** different members out of a group of **n** different elements (also known as the number of **combinations**) is calculated by the following formula:

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

For example, there are 2598960 ways to withdraw 5 cards out of a standard deck of 52 cards. Your task is to write a program that calculates **n! / (k! * (n-k)!)** for given **n** and **k** (1 < **k** < **n** < 100). Try to use only two loops. Examples:

n	k	n! / (k! * (n-k)!)
3	2	3
4	2	6
10	6	210
52	5	2598960

Problem 8. Catalan Numbers

In combinatorics, the Catalan numbers are calculated by the following formula:

$$C_n = \frac{1}{n+1}\binom{2n}{n} = \frac{(2n)!}{(n+1)!\,n!} = \prod_{k=2}^{n}\frac{n+k}{k} \qquad \text{for } n \geq 0.$$

Write a program to calculate the **n^th Catalan number** by given **n** (1 < n < 100). Examples:

n	Catalan(n)
0	1
5	42
10	16796

15	9694845

Problem 9. Matrix of Numbers

Write a program that reads from the console a positive integer number **n** (1 ≤ **n** ≤ 20) and **prints a matrix** like in the examples below. Use two nested loops. Examples:

n	matrix
2	1 2 2 3

n	matrix
3	1 2 3 2 3 4 3 4 5

n	matrix
4	1 2 3 4 2 3 4 5 3 4 5 6 4 5 6 7

Problem 10. Odd and Even Product

You are given **n** integers (given in a single line, separated by a space). Write a program that checks whether the product of the odd elements is equal to the product of the even elements. Elements are counted from **1** to **n**, so the first element is odd, the second is even, etc. Examples:

numbers	result
2 1 **1** 6 **3**	yes product = 6
3 10 **4** 6 **5** 1	yes product = 60
4 3 **2** 5 **2**	no odd_product = 16 even_product = 15

Problem 11. Random Numbers in Given Range

Write a program that enters 3 integers **n**, **min** and **max** (**min** ≤ **max**) and prints **n** random numbers in the range [**min**...**max**]. Examples:

n	min	max	random numbers
5	0	1	1 0 0 1 1
10	10	15	12 14 12 15 10 12 14 13 13 11

Note that the above output is just an example. Due to randomness, your program most probably will produce different results.

Problem 12. * Randomize the Numbers 1…N

Write a program that enters in integer **n** and prints the numbers 1, 2, …, **n** in random order. Examples:

n	randomized numbers 1…n
3	2 1 3
10	3 4 8 2 6 7 9 1 10 5

Note that the above output is just an example. Due to randomness, your program most probably will produce different results. You might need to use arrays.

Problem 13. Binary to Decimal Number

Using loops write a program that converts a binary integer number to its decimal form. The input is entered as **`string`**. The output should be a variable of type **`long`**. Do not use the built-in .NET functionality. Examples:

binary	decimal
0	0
11	3
1010101010101011	43691
11100001100001011001010000000	236476736

Problem 14. Decimal to Binary Number

Using loops write a program that converts an integer number to its binary representation. The input is entered as **`long`**. The output should be a variable of type **`string`**. Do not use the built-in .NET functionality. Examples:

decimal	binary
0	0
3	11
43691	1010101010101011
236476736	11100001100001011001010000000

Problem 15. Hexadecimal to Decimal Number

Using loops write a program that converts a hexadecimal integer number to its decimal form. The input is entered as **`string`**. The output should be a variable of type **`long`**. Do not use the built-in .NET functionality. Examples:

hexadecimal	decimal
FE	254
1AE3	6883
4ED528CBB4	338583669684

Problem 16. Decimal to Hexadecimal Number

Using loops write a program that converts an integer number to its hexadecimal representation. The input is entered as **`long`**. The output should be a variable of type **`string`**. Do not use the built-in .NET functionality. Examples:

decimal	hexadecimal
254	FE
6883	1AE3
338583669684	4ED528CBB4

Problem 17. * Calculate GCD

Write a program that calculates the **greatest common divisor** (**GCD**) of given two integers **a** and **b**. Use the **Euclidean algorithm** (find it in Internet). Examples:

a	b	GCD(a, b)
3	2	1
60	40	20
5	-15	5

Problem 18.* Trailing Zeroes in N!

Write a program that calculates with how many zeroes the factorial of a given number **n** has at its end. Your program should work well for very big numbers, e.g. n=100000. Examples:

n	trailing zeroes of n!	explaination
10	2	3628**00**
20	4	2432902008176640**000**
100000	24999	think why

Problem 19.** Spiral Matrix

Write a program that reads from the console a positive integer number **n** (1 ≤ **n** ≤ 20) and **prints a matrix** holding the numbers from **1** to **n*****n** in the form of **square spiral** like in the examples below. Examples:

n	matrix
2	1 2 4 3

n	matrix
3	1 2 3 8 9 4 7 6 5

n	matrix
4	1 2 3 4 12 13 14 5 11 16 15 6 10 9 8 7