

PROBLEM SOLVING PISTON CUP

INTRODUCTION

Piston cup is a drag race championship. The finish line is to develop problem solving. Your mind is your vehicle; flowcharts are your steering wheels and Pseudo-codes your accelerator. Race track is the series of problems below. The problems are in increasing difficulty requiring you to shift gears accordingly. You have to make flowchart first and then Pseudo-code for each problem. So for problem 1 first make a flowchart, then write corresponding pseudo-code and move on to problem 2 and so forth.

Good luck and see you at the finish line!

START YOUR ENGINES...

PROBLEM 1: ADULT OR MINOR

Given the applicant's age as input, determine whether he is an adult or not. In Pakistan the adult age is 18 years. (Example1: If input is 21 you must print 'Adult'; Example2: If input is 12 output is 'Minor')

PROBLEM 2: ADULT OR MINOR 2

In Pakistan the adult age for females is 16. Given the age and gender of the applicant determine, whether he or she is adult or minor.

PROBLEM 3: EVEN OR NOT

Mr. Bhoola does not know how to determine that an integer is even or odd. He has n number of integers. You are to make a flowchart (and eventually write pseudo-code) which he can follow and determine whether the number is even or odd. Your flowchart (and pseudo-code) must take n as an input first then allow the user to enter n number of integers and for each integer print even or odd.

1st GEAR...

PROBLEM 4: DATE VALIDATOR

Mr. Bhoola is not aware of Georgian Calendar dates. However, he knows that date can be in the format ddmmyyyy. As discussed in the class you are to make a date validator for Mr. Bhoola. Input will be in the format dd mm yyyy. Output must be 'Valid', if the date is a legitimate Georgian Calendar date or 'Invalid' otherwise.

PROBLEM 5: MULTIPLYING BY SUCCESSIVE ADDITION

Mr. Bhoola wants to make a flowchart (you must also write pseudo-code) for multiplying two numbers. But he is not aware of multiplying directly. He can only multiply by successive additions. How will Mr. Bhoola's flowchart look? Input is a set of two integers 'a' & 'b' and output is 'a' times 'b'.

PROBLEM 6: MEAN MACHINE

By now you know that Mr. Bhoola is poor at mathematics and needs your help again. He wants to calculate average of n integers this time. He will first enter the number N , and then input N number of integers. Your flowchart and pseudo-code must sum up the N integers and give their average as output. (E.g. Input: 3 13, 10, 22; output: 15)

2nd GEAR...

PROBLEM 7: CALENDAR PRINTING

Mr. Bhoola is fed-up of giving individual dates as inputs. He wants a complete calendar starting from 1st January to 31st December for a given year. Your input for this problem is a year in format yyyy.

PROBLEM 8: PATTERN PRINTING

Mrs. Denise works at a textile designing company. Her new print can be of varying size and it is very difficult to recreate them by hand for huge number. Fortunately the print is easy enough to be recreated in computer. You are to make and flowchart and eventually write a pseudo-code to print this design. The design is a N by N sized right-angled triangle of asterisks. Mrs. Denise will provide the size $N > 0$. E.g. Mrs. Denise gives an input of 4 then the output is:

```
*
**
***
****
```

PROBLEM 9: PRIME NUMBERS

Again Mr. Bhoola is unable to tell whether a number is Prime or not. You need to devise a naive primarily testing algorithm by drawing a flowchart and then writing pseudo-code. Keep in mind that you need not check all the numbers from 2 to $N-1$. Dividing from 2 to \sqrt{N} is sufficient for primality testing. Mr. Bhoola will input an integer greater than 0. E.g. Input is 9 – Output is 'Composite'.

3rd GEAR...

PROBLEM 10: NEW DESIGN

Mrs. Denise has come up with a new design. The new design is not so different from the old one. This time there are two right-angled triangles as shown below for input of 4. Mrs. Denise can give any integer greater than 0 as input.

```
*
**
***
****
***
**
*
```

PROBLEM 11: ANOTHER NEW DESIGN

Mrs. Denise is on a roll and coming up with brilliant designs every day. Her latest design for input of 4 is shown below. As before Mrs. Denise can give any integer greater than 0 as input.

```
*000
**00
***0
****
```

PROBLEM 11: DIGIT PRINTING

Mr. Bhoola is conducting a Lucky draw competition. He wants to display the lucky draw number on a screen. To create more suspense he wants to display the number digit by digit. The lucky draw number consists of 7 digits. So e.g. if the lucky draw number is 3456712 the screen will show digits in following sequence 2 – 1 – 7 – 6 – 5 – 4 – 3. It is up to the computer program to separate the number digits and display them. You are to draw a flowchart and eventually write a pseudo-code for the computer program. The input to the program is a 7-digit integer.

4th GEAR...

PROBLEM 12: PRIME NUMBERS LESS THAN n

Mr. Bhoola is fed-up of putting in numbers and seeing that if it is a prime. Mr. Bhoola wants a computer program that can print sequence of prime numbers less than integer n . The input to the program will be an integer n greater than 0. E.g. if n is 20 the output should be 2, 3, 5, 7, 11, 13, 17, 19. Draw a flowchart and write pseudo-code.

PROBLEM 13: NUMBER PERSISTENCY

Multiply all the digits of a number n by each other, repeating with the product until a single digit is obtained. The number of steps required is known as the multiplicative persistence, and the final digit obtained is called the multiplicative digital root of n .

For example, the sequence obtained from the starting number 9876 is (9876, 3024, 0), so 9876 has a multiplicative persistence of two and a multiplicative digital root of 0.

Draw a flowchart and eventually write pseudo-code for finding number persistency and multiplicative root of any integer n greater than 0 given an input.

PROBLEM 14: SWAPPING 2 NUMBERS

When sorting a list of integers we are required to swap two variables. Given two integers as input X and Y. Swap X, Y if X is greater than Y. E.g. if input is 51, 23 (i.e. X=51 and Y=23); the output should be X=23 and Y=51 with values of X and Y actually swapped. Name this Flowchart (and Pseudo-code) 'SWAP'.

5TH GEAR

PROBLEM 15: SORTING 3 NUMBERS

Use the keyword 'SWAP' for the flowchart (and pseudo-code) in problem 14 sort 3 integers given as input. Is the resulting sorting order ascending or descending? Draw flowchart (and write pseudo-code) for SWAP2 that will sort 3 numbers in the other order.

6TH GEAR

PROBLEM 16: BINARY PRINTING

Given an integer $n > 0$ print its binary. E.g. if input is 12 the output is 1100.

PROBLEM 17: SORTING 4 NUMBERS

Sort 4 integers a, b, c and d given as input.

PROBLEM 18: LIMITED MEMORY

Mr. Bhoola has been assigned to write a computer program to swap 2 variables. The problem is the program will run on a limited memory embedded system. Therefore, Mr. Bhoola cannot use another temporary variable or any other register.

PROBLEM 19: TAXICAB NUMBERS

Ramanujan Number is the smallest number expressible as the sum of two cubes in two different ways. The two different ways are these:

$$1729 = 1^3 + 12^3 = 9^3 + 10^3$$

The second such number is $2^3 + 16^3 = 9^3 + 15^3 = 4104$. Sequences of such numbers are called Taxicab numbers. Your task, if you wish to accept it, is to draw a flowchart and eventually write a pseudo-code to write first n taxicab numbers (provided $n > 0$).

FINISH LINE

PROBLEM 20: SPIRAL COUNTING (TAKEN FROM A PROGRAMMING COMPETITION)

For this problem assume you have a grid of size n by n where $n > 4$ and $\sqrt{n} = q$ where q is an integer. Meaning n has a perfect square root. Cells in the grid can be accessed using the column number and row number. Column numbers and row numbers start from 0 and top left corner. You are to fill the grid with integers 1 to n starting from the center of the grid spiraling out from right. The output should be the cell number (row & column) and corresponding integer to put in it. See the example below for input of **9**.

	0	1	2
0	5	4	3
1	6	1	2
2	7	8	9

Output:

Put 1 in cell 1, 1
Put 2 in cell 2, 1
Put 3 in cell 2, 0
Put 4 in cell 1, 0
Put 5 in cell 0, 0
Put 6 in cell 0, 1
Put 7 in cell 0, 2
Put 8 in cell 1, 2
Put 9 in cell 2, 2

	0	1	2	3
0	16	15	14	13
1	5	4	3	12
2	6	1	2	11
3	7	8	9	10

Output:

Put 1 in cell 1, 2
Put 2 in cell 2, 2
Put 3 in cell 2, 1
Put 4 in cell 1, 1
Put 5 in cell 0, 1
Put 6 in cell 0, 2
Put 7 in cell 0, 3
Put 8 in cell 1, 3
Put 9 in cell 2, 3
Put 10 in cell 3, 3
Put 11 in cell 3, 2
Put 12 in cell 3, 1
Put 13 in cell 3, 0
Put 14 in cell 2, 0
Put 15 in cell 1, 0
Put 16 in cell 0, 0