

CS 101: Introduction to Computer Science

Mahindra École Centrale

Duration: 2 hours | *CS101 First Lab Examination* | Total 20 marks

February 23rd to 27th, 2015

For the first two problems, you need to do three things (in this order):

1. Find a logical or mathematical solution, that you will write and explain in English and using mathematical notations. You will write this on an external piece of paper, with your name, roll number, date and title of the problem.
2. Write a *valid* Python program that solves the problem, and produces correct output, for the two values (the example one, which has to be the same as the one given in the problem, and the target)
These Python programs will be saved on the Desktop of the computer used for the exam, under a folder named with your roll number (e.g. 14XJ00579), and used to evaluate you (for no more than 50% of the grade for that exercise),
3. Additionally, write the target output on you answer paper **and** on this question paper that you have to give back at the end.

These 3 components will be evaluated to produce a grade for each problem.

Problem I : product of multiple of 3 and 5

(Marks: 5)

Find the product of all the positive integer numbers ($n > 0$) that are divisible by 3 **or** 5 and that are below 30 (ie. $n < 30$).

For example, for the numbers below 15, we have 3, 5, 6, 9, 10 and 12 so the product is $3 \times 5 \times 6 \times 9 \times 10 \times 12 = 97200$.

Output for problem I:

Problem II : sum of the first factorial numbers

(Marks: 5)

Give the first 14 values of the factorial numbers ($0!, 1!, \dots, 13!$), and give their sum.

You also need to find from which value of n its factorial $n!$ is strictly greater than 10^{15} .

Hint: We remind that the factorial function is defined with $0! = 1, n! = 1 \times 2 \times \dots \times n = \prod_{i=1}^n i$

(and satisfies $(n + 1)! = (n + 1) \times n!$ recursively).

Output for problem II:

Problem III : the railway problem (longer)**(Marks: 10)**

There are 2 classes of trains – A (express) and B (goods) – that can travel on a section of railway track $PQRS$ (see Fig.) 30 kms long. This track section is equally split into 3 parts.

- The first PQ part has a positive (i.e. adverse) gradient that decelerates a goods train by 20 kms/hours and the express train by 80% of that rate.
- The second stretch QR is a level plain.
- The third stretch RS has a negative (i.e. downward) gradient that accelerates a goods train by 16 kms/hours and an express train by 75% of that amount.

Now assume that you are writing a program that throws commands to the train driver on a screen. The commands are to “Apply Power” immediately if the speed falls below 20 kms/hours for the train type B and 25 kms/hours for train type A, and alternately to “Apply Brake” if the speed goes beyond 50 kms/hours for the train type B and 60 kms/hours for type A.

Importantly, the “power” or “brake” applied by the driver is just sufficient to nullify the corresponding deceleration or acceleration of that stretch, respectively, and is taken off as soon as the driver enters the level section. Further, the driver is asked to enter the “Entry Speed” at the instant he enters this track zone of interest, i.e. crosses point P.

Now write the program using your knowledge of basic arithmetic and what you have so far learnt in programming, which provides the driver with the above commands at entry and other action points (“action” is for driver). At the action points, also print in float the “number of kms entered into that section”. Your first inputs that you will request from driver will be the train type and train speed.

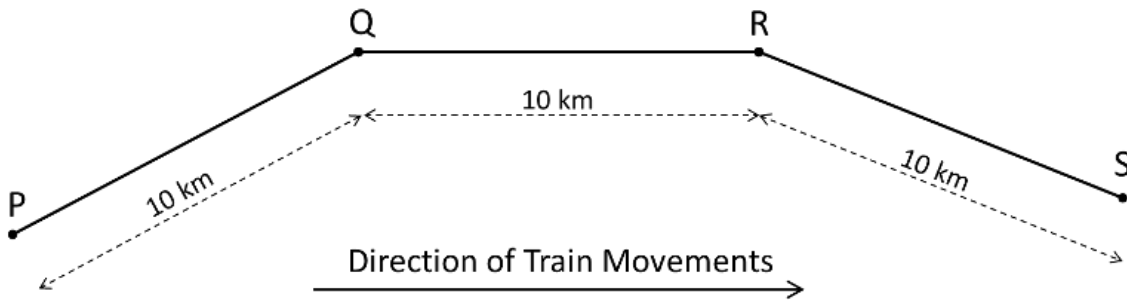


Figure 1: Section of railway track $PQRS$.

Important:

- You are **not** supposed to start coding right away.
- Instead, first write out systematically the logical steps of the computation, from start to finish, on your answer script.
- Only then convert this into code. Your written computational steps contain as many marks as the code itself.

Hint: Use these three equations of kinematics:

$$(a) v = u + at,$$

$$(b) s = ut + \frac{1}{2}at^2,$$

$$(c) v^2 = u^2 + 2as$$

where u and v are the initial and final velocities covered in time t along distance s , and a is the constant rate of acceleration.