Group Assignment 1 : Introducing C

1. Write a program to determine the smallest positive integer n with the following property.

   - Let $n = a^k a^{k-1}...a^1 a^0$ be the decimal representation of n with $a^k > 0$.
   - Look at the integer:
     $n' = a^0 a^k a^{k-1}..a^2 a^1$ (the cyclic right shift of n).

   The desired property of n is that n' must be a proper integral multiple of n.

2. Write a program to find the smallest positive integer n with the property that the decimal expansion of 2^n starts with the four digits 2005, i.e., $2^n = 2005...$ (Hint: Take log.)

3. Read an English sentence from the terminal.
   a) Count and print the number of occurrences of the alphabetic letters (a through z) in it.
   b) Also print the total number of distinct alphabetic letters in the sentence. Make no distinction between upper and lower case letters, i.e., 'a' is treated the same as 'A', 'b' the same as 'B' and so on. Neglect non-alphabetic characters (digits, spaces, punctuation symbols etc.).

4. Write a program that scans a positive integer .
   a) Checks if the integer is a perfect number (i.e., a number which is equal to the sum of all its proper integral divisors, e.g., 6 = 1+2+3).

5. Write a program that reads a positive integer n and lists all primes between 1 and n. Use the sieve of Eratosthenes described below:

   - Use an array of n cells indexed 1 through n.
   - Since C starts indexing from 0, one may, for the ease of referencing, use an array of n+1 cells (rather than n). Initially all the array cells are unmarked.
   - During the process one marks the cells with composite indices. An unmarked cell holds the value 0, a marked cell holds 1. Henceforth, let us abbreviate "marking the cell at index i" as "marking i".

6. Input two strings a and b from the user .
   a) Check if b is a substring of a.
   b) If b is a substring of a, then your program should also print the leftmost position of the leftmost match of b in a.

7. A Pythagorean triple is a triple (a,b,c) of positive integers with the property that a2+b2=c2. Write a program that scans a positive integer value k .
   a) Outputs all Pythagorean triples (a,b,c) with 0<a<=b<c<=k.

8. Generate a random sequence of birthdays and store the birthdays in an array.
   a) As soon as a match is found, report that.
   b) Also report how many birthdays were generated to get the match.

9. Write a program that does the following:
   a) Read a decimal integer
   b) Print the ternary (base 3) representation of the integer.

10. An ant is sitting at the left end of a rope of length 10 cm. At t=0 the ant starts moving along the rope to reach the other end of the rope. The ant has a speed of 1 cm per second.

    After every second the rope stretches instantaneously and uniformly (along its length) by 10 cm with the left end fixed at the point from where the ant started its journey. Suppose that the ant's legs provide it sufficient friction in order to withstand the stretching of the rope.

    a) Write a program to demonstrate that the ant will be able to reach the right end of the rope.
    b) Your program should also calculate how many seconds the ant would take to achieve this goal. You may assume that the length of the ant is negligible (i.e., zero).

    Note: The ant would reach the right end of the rope, even if its initial length and stretching per second were 1 km (or even a billion kilometers) instead of 10 cm. But for these dimensions the ant would take such an unbelievably large time that your program will not give you the confirmation in your life-time. Moreover, you will require more precision than what double can provide. Try to solve this puzzle mathematically.

11. Write a program that does the following:
    a) Scan six real numbers a,b,c,d,e,f .
    b) Compute the point of intersection of the straight lines:

       ax + by = c
       dx + ey = f

    Your program should specifically handle the case that the two given lines are parallel.

12. Let m and n be 32-bit unsigned integers.
    - Use bit operations to assign to m the following functions of n:
      a) 1 if n is odd, 0 if n is even.
      b) 1 if n is divisible by 4, 0 otherwise.
      c) 2n (Assume that n<=31).
      d) n rotated by k positions to the left for some integer k>=0.
      e) n rotated by k positions to the right for some integer k>=0.

13. Input four integers a, b, c and d with b and d positive.
    a) Output the rational numbers (not their float equivalents) :
       1. (a/b)+(c/d),
       2. (a/b)-(c/d) and
       3. (a/b)*(c/d).
    b) Output the rational numbers in lowest terms, that is, in the form m/n with n>0 and gcd(m,n)=1.

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