

Problem G: A to Z Numerals

Source file: numeral.{c, cpp, java}

Input file: numeral.in

Roman numerals use symbols I, V, X, L, C, D, and M with values 1, 5, 10, 50, 100, 500, and 1000 respectively. There is an easy evaluation rule for them:

Rule Δ : Add together the values for each symbol that is either the rightmost or has a symbol of no greater value directly to its right. Subtract the values of all the other symbols.

For example: $MMCDLXIX = 1000 + 1000 - 100 + 500 + 50 + 10 - 1 + 10 = 2469$.

Further rules are needed to uniquely specify a Roman numeral corresponding to a positive integer less than 4000:

1. The numeral has as few characters as possible. (IV not IIII)
2. All the symbols that make positive contributions form a non-increasing subsequence. (XIV, not VIX)
3. All subtracted symbols appear as far to the right as possible. (MMCDLXIX not MCMDLIXX)
4. Subtracted symbols are always for a power of 10, and always appear directly to the left of a symbol 5 or 10 times as large that is added. No subtracted symbol can appear more than once in a numeral.

Rule 4 can be removed to allow shorter numerals, and still use the same evaluation rule: $IM = -1 + 1000 = 999$, $ILIL = -1 + 100 + -1 + 100 = 198$, $IVL = -1 - 5 + 100 = 94$. This would not make the numerals unique, however. Two choices for 297 would be $CCVCII$ and $ICICIC$. To eliminate the second choice in this example, Rule 4 can be replaced by

4'. With a choice of numeral representations of the same length, use one with the fewest subtracted symbols.

Finally, replace the Roman numeral symbols to make a system that is more regular and allows larger numbers: Assign the English letter symbols a, A, b, B, c, C, ..., y, Y, z, and Z to values 1, 5, 10, $5(10)$, 10^2 , $(5)10^2$, ..., 10^{24} , $(5)10^{24}$, 10^{25} , and $(5)10^{25}$ respectively. Though using the *whole* alphabet makes logical sense, your problem will use only symbols a-R for easier machine calculations. ($R = (5)10^{17}$.)

With the new symbols a-z, the original formation rules 1-3, the alternate rule 4', and the evaluation rule Δ , numerals can be created, called A to Z numerals. Examples: $ad = -1 + 1000 = 999$; $aAc = -1 - 5 + 100 = 94$.

Input: The input starts with a sequence of one or more positive integers less than $(7)10^{17}$, one per line. The end of the input is indicated by a line containing only 0.

Output: For each positive integer in the input, output a line containing only an A to Z numeral representing the integer.

Do not choose a solution method whose time is exponential in the number of digits!

Example input:	Example output:
999	ad
198	acac
98	Acaaa
297	ccAcaa
94	aAc
666666666666666666	RrQqPpOoNnMmLlKkJjIiHhGgFfEeDdCcBbAa
0	