

Task: POD

Subsequences



XXVI OI, Stage I. Source file pod.* Available memory: 256 MB.

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Write a program that, for a given non-negative integer n , generates a relatively short string over a small sized alphabet which has exactly n distinct subsequences.

Formally, let w be a string composed of successive characters w_1, w_2, \dots, w_m . Then any string of the form $w_{i_1}w_{i_2}\dots w_{i_k}$, where $0 \leq k \leq m$ and $1 \leq i_1 < i_2 < \dots < i_k \leq m$, is called a subsequence of w . In particular, an empty string (of 0 letters) is a subsequence of w . Two subsequences are distinct if the strings they represent are distinct. For example, the string `ioi` has seven distinct subsequences: the empty subsequence, `i`, `o`, `ii`, `io`, `oi`, and `ioi`. Note that the single letter subsequences `i` appears twice in `ioi`, but it counts only once.

Input

In the first line of the standard input, there is a single positive integer q ($1 \leq q \leq 10\,000$) that specifies the number of test data sets. The q lines that follow describe these data sets. Each line contains a single positive integer n ($2 \leq n \leq 10^{18}$) – the desired number of subsequences (including the empty one) of the string to be generated.

Output

Your program should print exactly q lines to the standard output, with the answers for successive input data sets. Each line should contain a string of at most 1000 characters, each of which may be any digit or any letter of the English alphabet (lower- or upper-case); all these characters are distinguishable when subsequences are compared. The output string should have exactly n distinct subsequences.

Should more than one answer be correct, any of those will be accepted.

If no string satisfies the requirements, the character `!` (exclamation mark) should be printed instead of any string.

Example

For the following input data:

5
7
10
42
15
512

a correct answer is:

`ioi`
`Mmmmm`
`ERRATA`
`0000FF`
`R3GuLaM1N`

Grading

The set of tests consists of the following subsets. Within each subset, there may be several unit tests.

Subset	Property	Score
1	each number n has a factorization into prime factors whose sum does not exceed 300	20
2	each number n is a difference of two powers of two	10
3	the binary representations of n do not end in 01 nor 010, nor do they contain adjacent zeros	10
4	$n \leq 10^6$, randomly generated numbers	20
5	$n \leq 10^{18}$, randomly generated numbers	30
6	$n \leq 10^{18}$, non-randomly generated numbers	10