Problem E. Binary Exponentiation

- 2023.10.23 00:30 Update: Fixed typo in Sample Input description.

Problem Description

Given four integers x, y, k, and p, please calculate $\left\lfloor \frac{x^y}{k} \right\rfloor \bmod p$.

There are t testcases.

Input Format

- line 1: t
- line $2+i$ ($0 \leq i \leq t-1$): x y k p

Output Format

- line $1+i$ ($0 \leq i \leq t-1$): the answer for the i^{th} testcase.

Constraints

- $1 \leq t \leq 100\,000$.
- $1 \leq x, y, k, p \leq 10^9$.
- All the inputs are integers.

Subtasks

1. (10 points) $k = 1$; $y \leq 100$.
2. (65 points) $k = 1$.
3. (10 points) $k = 2$.
4. (5 points) $y \leq 100$.
5. (10 points) No additional constraints.

No.	Testdata Range	Time Limit (ms)	Memory Limit (KiB)
Samples	1	1000	262144
1	2	1000	262144
2	2-3	1000	262144
3	4	1000	262144
4	2,5	1000	262144
5	1-6	1000	262144

Samples

Sample Input 1

```
7
2 20 1 998244353
987654321 100 1 1000000000
998244352 100 1 998244353
1000000000 1 1 100
314159265 358979323 1 846264338
314159265 358979323 2 846264338
314159265 358979323 846264338 327950288
```

This sample input satisfies the constraints of Subtask 5.

Sample Output 1

```
1048576
409912001
1
0
604903687
725584012
36855733
```

- In the 1^{st} testcase: $2^{20} \bmod 998\,244\,353 = 1\,048\,576$.
- In the 3^{rd} testcase: $998\,244\,352^{100} \bmod 998\,244\,353 = (-1)^{100} \bmod 998\,244\,353 = 1$.
- In the 4^{th} testcase: $1\,000\,000\,000^{1} \bmod 100 = 0$.