Day 6: Bitwise Operators

HackerRank

Objective

Today, we're practicing *bitwise operations*. Check the attached tutorial for more details.

Task

We define S to be a sequence of distinct sequential integers from 1 to n; in other words, $S = \{1, 2, 3, \ldots, n\}$. We want to know the maximum bitwise AND value of any two integers, a and b (where $a < b$), in sequence S that is also *less than a given integer*, k.

Complete the function in the editor so that given n and k, it returns the maximum $a \,\&\, b < k$.

Note: The $\&$ symbol represents the bitwise AND operator.

Input Format

The first line contains an integer, q, denoting the number of function calls.
Each of the q subsequent lines defines a dataset for a function call in the form of two space-separated integers describing the respective values of n and k.

Constraints

- $1 \leq q \leq 10^3$
- $2 \leq n \leq 10^3$
- $2 \leq k \leq n$

Output Format

Return the maximum possible value of $a \,\&\, b < k$ for any $a < b$ in sequence S.

Sample Input 0

```
3
5 2
8 5
2 2
```

Sample Output 0

```
1
4
0
```

Explanation 0

We perform the following $q = 3$ function calls:

1. When $n = 5$ and $k = 2$, we have the following possible a and b values in set $S = \{1, 2, 3, 4, 5\}$:

$$\begin{array}{lll} & ab & a \,\&\, b \\ 1 & 2001 \,\&\, 010 & = (000)_2 \Rightarrow (0)_{10} \\ 1 & 3001 \,\&\, 011 & = (001)_2 \Rightarrow (1)_{10} \\ 1 & 4001 \,\&\, 100 & = (000)_2 \Rightarrow (0)_{10} \\ 1 & 5001 \,\&\, 101 & = (001)_2 \Rightarrow (1)_{10} \end{array}$$

a b $a \,\&\, b$
2 3 $010 \,\&\, 011 = (010)_2 \Rightarrow (2)_{10}$
2 4 $010 \,\&\, 100 = (000)_2 \Rightarrow (0)_{10}$
2 5 $010 \,\&\, 101 = (000)_2 \Rightarrow (0)_{10}$
3 4 $011 \,\&\, 100 = (000)_2 \Rightarrow (0)_{10}$
3 5 $011 \,\&\, 101 = (001)_2 \Rightarrow (1)_{10}$
4 5 $100 \,\&\, 101 = (100)_2 \Rightarrow (4)_{10}$

The maximum of any $a \,\&\, b$ that is also $< k$ is 1, so we return 1.

2. When $n = 8$ and $k = 5$, the maximum of any $a \,\&\, b < k$ in set $S = \{1, 2, 3, 4, 5, 6, 7, 8\}$ is 4 (see table above), so we return 4.
3. When $n = 2$ and $k = 2$, the maximum of any $a \,\&\, b < k$ in set $S = \{1, 2\}$ is 0 (see table above), so we return 0.

Sample Input 1

```
2
9 2
8 3
```

Sample Output 1

```
1
2
```

Explanation 1

We perform the following $q = 2$ function calls:

1. When $n = 9$ and $k = 2$, the maximum of any $a \,\&\, b < k$ in set $S = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ is 1 (see table above), so we return 1.
2. When $n = 8$ and $k = 3$, the maximum of any $a \,\&\, b < k$ in set $S = \{1, 2, 3, 4, 5, 6, 7, 8\}$ is 2 (see table above), so we return 2.