Xoring Ninja

HackerRank

An XOR operation on a list is defined here as the *xor* ($\oplus$) of all its elements (e.g.: $XOR(\{A, B, C\}) = A \oplus B \oplus C$).

The $XorSum$ of set S is defined here as the sum of the XORs of all S's non-empty subsets. If we refer to the set of S's non-empty subsets as S', this can be expressed as:

$$XorSum(S) = \sum_{i=1}^{2^n-1} XOR(S'_i) = XOR(S'_1) + XOR(S'_2) + \cdots + XOR(S'_{2^n-2}) + XOR(S'_{2^n-1})$$

For example: Given set $S = \{n_1, n_2, n_3\}$

- The set of possible non-empty subsets is:
  $S' = \{\{n_1\}, \{n_2\}, \{n_3\}, \{n_1, n_2\}, \{n_1, n_3\}, \{n_2, n_3\}, \{n_1, n_2, n_3\}\}$
- The $XorSum$ of these non-empty subsets is then calculated as follows:
  $XorSum(S) = n_1 + n_2 + n_3 + (n_1 \oplus n_2) + (n_1 \oplus n_3) + (n_2 \oplus n_3) + (n_1 \oplus n_2 \oplus n_3)$

Given a list of n space-separated integers, determine and print $XorSum \,\%\, (10^9 + 7)$.

Note: The cardinality of powerset(n) is 2^n, so the set of non-empty subsets of set S of size n contains $2^n - 1$ subsets.

Input Format

The first line contains an integer, T, denoting the number of test cases.
Each test case consists of two lines; the first is an integer, n, describing the size of the set, and the second contains n space-separated integers $(a_1, a_2, \ldots, a_n)$ describing the set.

Constraints

$1 \le T \le 5$
$1 \le n \le 10^5$
$0 \le a_i \le 10^9,\ i \in [1, n]$

Output Format

For each test case, print its $XorSum \,\%\, (10^9 + 7)$ on a new line; the i^{th} line should contain the output for the i^{th} test case.

Sample Input

```
1
3
1 2 3
```

Sample Output

```
12
```

Explanation

The input set, $S = \{1, 2, 3\}$, has 7 possible non-empty subsets:

$S' = \{\{1\}, \{2\}, \{3\}, \{1, 2\}, \{2, 3\}, \{1, 3\}, \{1, 2, 3\}\}$.

We then determine the XOR of each subset in S':
$XOR(\{1\}) = 1$
$XOR(\{2\}) = 2$
$XOR(\{3\}) = 3$
$XOR(\{1, 2\}) = 1 \oplus 2 = 3$
$XOR(\{2, 3\}) = 2 \oplus 3 = 1$
$XOR(\{1, 3\} = 1 \oplus 3 = 2$
$XOR(\{1, 2, 3\} = 1 \oplus 2 \oplus 3 = 0$

Then sum the results of the XOR of each individual subset in S', resulting in $XorSum = 12$. We print 12, because $12 \,\%\, (10^9 + 7) = 12$.