# Problem B. Knapsack Problem (Real)

- 2023.12.08 03:30 Update: Strengthen tests, rejudged solutions.
- 2023.12.06 18:30 Update: Memory Limit 4 MiB $\rightarrow$ 16 MiB, rejudged solutions.

## Problem Description

There are $n$ items, each item $i$ has a cost $c_i$ and a value $v_i$, and can be picked infinitely many times. Let $S$ be the multiset of items you picked, please find the maximum value of $\sum_{i \in S} v_i$ under the constraint of $\sum_{i \in S} c_i \leq V$.

There are $t$ test cases.

## Input Format

- line 1: $t$

$t$ blocks:

- line 1: $n \;\; V$
- line 2: $c_1 \;\; c_2 \;\; \ldots \;\; c_n$
- line 3: $v_1 \;\; v_2 \;\; \ldots \;\; v_n$

## Output Format

$t$ blocks:

- line 1: $ans$

## Constraints

- $1 \leq t \leq 10$.
- $1 \leq n \leq 100\,000$.
  - Sum of $n$ across all test cases $\leq 100\,000$.
- $1 \leq V \leq 10^9$.
- $1 \leq c_i \leq 1200$ for $i = 1, 2, \ldots, n$.
- $1 \leq v_i \leq 10^9$ for $i = 1, 2, \ldots, n$.
- All input values are integers.

## Subtasks

1. (25 points) $c_i \leq 20$ for $i = 1, 2, \ldots, n$; $V \leq 20$.
2. (35 points) $c_i \leq 100$ for $i = 1, 2, \ldots, n$; $V \leq 500$.
3. (15 points) $c_i \leq 100$ for $i = 1, 2, \ldots, n$; $V \leq 60\,000$.
4. (10 points) $c_i \leq 100$ for $i = 1, 2, \ldots, n$.
5. (10 points) $v_i = c_i$ for $i = 1, 2, \ldots, n$.
6. (5 points) No additional constraints.

- You can get $60\%$ of a subtask's score if you use no more than $256$ MiB of memory;
- furthermore, you can get another $40\%$ if you use no more than 16 MiB.

| No. | Testdata Range | Time Limit (ms) | Memory Limit (KiB) |
|---|---|---|---|
| Samples | 1 | 2000 | 262144 |
| 1 | 2 | 2000 | 262144 |
| 2 | 2-4 | 2000 | 262144 |
| 3 | 2-7 | 2000 | 262144 |
| 4 | 2-9 | 2000 | 262144 |
| 5 | 10-11 | 2000 | 262144 |
| 6 | 1-15 | 2000 | 262144 |

## Samples

### Sample Input 1

```
4
5 23
5 9 8 8 3
1 11 9 6 3
3 8
3 4 5
7 5 6
1 3
1
1000000000
1 1199
1200
1000000000
```

This sample input satisfies the constraints of Subtask 6.

Sample Output 1

```
26
14
3000000000
0
```

- In the first test case, one possible solution is to pick the multiset $\{2, 3, 5, 5\}$, which has a total cost of $23 = c_2 + c_3 + c_5 + c_5$ and a total value of $26 = v_2 + v_3 + v_5 + v_5$.
- In the second test case, the best solution is to pick the multiset $\{1, 1\}$ with cost $6$ and value $14$.
- In the third test case, the best solution is to pick the multiset $\{1, 1, 1\}$ with cost $3$ and value $3 \cdot 10^9$.
- In the fourth test case, you can not afford any item, thus the maximum value is $0$.