

# Algorithm Design Laboratory with Applications

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**Problem:** *Deep Sea Research.*

You are a scuba diver collaborating to a deep sea research project. The supply of air in your tanks is limited and the researchers need at least  $W$  kilograms of some special kind of rocks.

You have a map listing the locations of the  $n$  rocks  $r_1, \dots, r_n$  of interest in the area. Each rock  $r_i$  has a weight of  $w_i \in \mathbb{N}^+$  and needs  $t_i \in \mathbb{N}^+$  minutes to be collected.

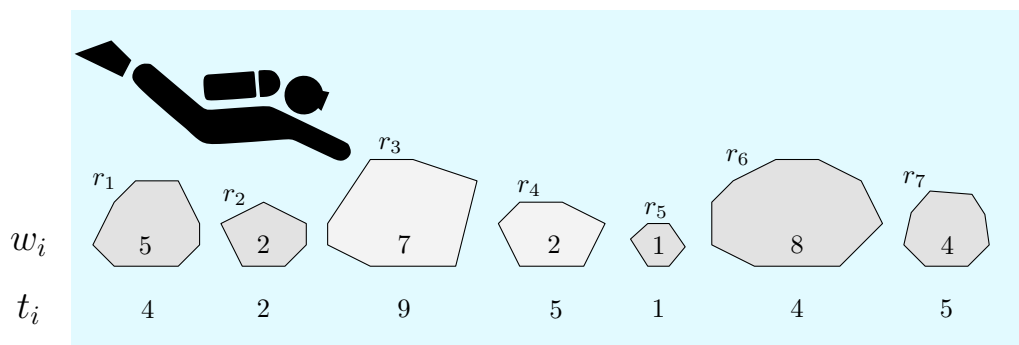
Design an algorithm that computes the minimum number  $M$  of minutes needed to collect a subset of rocks of total weight at least  $W$ .

**Input.** The input consists of a set of instances, or *test-cases*, of the previous problem. The first line contains the number  $T$  of test-cases. The first line of each test case contains the integers  $n$  and  $W$ . The next line contains the  $n$  integers  $w_1, \dots, w_n$ . The third and fine line of the test case contains the  $n$  integers  $t_1, \dots, t_n$ .

**Output.** The output consists of  $T$  lines. The  $i$ -th line is the answer to the  $i$ -th test-case and contains the integer  $M$ .

**Assumptions.**  $1 \leq T \leq 10$ ;  $1 \leq n \leq 2^{11}$ ;  $1 \leq W \leq 2^{18}$ ;  $\forall i = 1, \dots, n, 1 \leq w_i \leq 2^8$ ;  $\forall i = 1, \dots, n, 1 \leq t_i \leq 2^{16}$ .

**Example.**



*Input (corresponding to the above picture):*

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```
1
7 20
5 2 7 2 1 8 4
4 2 9 5 1 4 5
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*Output (corresponding to subset of rocks  $\{r_1, r_2, r_5, r_6, r_7\}$ ):*

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16
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**Requirements.** Your algorithm should require  $O(nW)$  time (with reasonable hidden constants).

**Notes.** A reasonable implementation should not require more than 1 second for each input file.