Fixed-Income Security Trade Allocation

A *portfolio* is a grouping of financial assets, such as stocks, bonds, or *fixed-income securities*. Each portfolio is managed by a *Portfolio Manager* who is in charge of sending portfolio orders to a *Trader*.

A *Trader* receives orders of varying sizes from different portfolios to buy a quantity of a *security* on the market. They then identify a *Seller* that is willing to sell units of the desired security.

In a best-case scenario, the *Seller* is selling enough of the security to fulfill all of the portfolio orders for the security; however, if that is not the case, the *Trader* must buy as much of the security as possible and *fairly allocate it amongst the portfolios*.

Fixed-Income Security

A fixed-income security has the following properties:

- $minimum\_trade\_size$ - The smallest number of units that can be traded with this security.
- $increment$ - The number of units the trade can be incremented with.
- $tradeable\_amount = (minimum\_trade\_size) + (increment \times n)$, where n is a non-negative integer.
- $avaliable\_units$ - The number of units of the security that are available for purchase on the market.

Fixed-Income Trade Orders

A fixed-income *Trader* has the following information:

- $portfolio\_order$ - The number of units of the fixed-income security that a single portfolio wants to buy.
- $total\_order$ - The total (sum) number of units made up of all the underlying $portfolio_order$s.

Defining a Proportional Allocation

If there are not enough $avaliable\_units$ to fulfill all of the portfolio orders, we must find the proportional allocation for each portfolio's order of the $available\_units$ on the market.

We get a portfolio's $proportional\_allocation$ with this expression:

$$proportional\_allocation = \frac{portfolio\_order}{total\_order} \times available\_units$$

How Do We Fairly Allocate Units?

- Iterate through every underlying $portfolio\_order$ from smallest to largest (if two portfolios order the same number of units, then sort them lexicographically by ascending ID) and apply the following process:
    - If the portfolio's $proportional\_allocation$ is less than the $minimum\_trade\_size$, check if $proportional\_allocation$ is greater than $\frac{minimum\_trade\_size}{2}$.
        - If false, do not allocate anything.

        - If true, attempt to allocate the $minimum\_trade\_size$ within the defined rules.
            - If this fails; allocate nothing.
    - If the portfolio's $proportional\_allocation$ is greater than or equal to $minimum\_trade\_size$:
        - If the $proportional\_allocation$ is larger than or equal to the $portfolio\_order$, allocate the $portfolio\_order$.
        - If the $proportional\_allocation$ *is not* a $tradeable\_amount$, *round it down* to the closest $tradeable\_amount$ that you can allocate within the defined rules. If you fail to find a $tradeable\_amount$ that satisfies the rules, allocate nothing.
    - After allocating units (including the case when you allocate nothing) to a portfolio, perform the following steps to ensure that as much of the available security is purchased as is possible:
        - Recalculate the $total\_order$ based on the orders from the remaining portfolios (i.e., those whose orders haven't yet been allocated).
        - Subtract the quantity of units that were just allocated to an order and recalculate $avaliable\_units$.
        - Recalculate the $proportional\_allocation$ of each portfolio awaiting allocation based on the remaining $avaliable\_units$.

Rules That Always Hold

- A portfolio manager *only* orders tradeable amounts from the *Trader*.
- Each portfolio has to issue its own trade, hence *the quantity allocated to each portfolio must be a* $tradeable\_amount$.
- An *untradeable amount* is a value that cannot be represented as a *tradeable amount*. Note that an exception of 0 is allowed (meaning that 0 is a tradeable amount). You must try to never leave a portfolio with leftover units ($portfolio\_order - allocated\_amount$) that can't be traded on the market (i.e., an untradeable amount).

Given the basic information for a fixed-income security and a list of portfolio orders, find the $proportional\_allocation$ for each portfolio using the rules and processes defined above. Then, print each $portfolio\_identifier$ along with the amount of the security allocated to it as two space-separated values on a new line. Order your output alphabetically by $portfolio\_identifier$.

Input Format

The first line contains an integer, T, denoting the number of portfolios hoping to place orders.
The second line contains three space-separated integers denoting the respective values for the $minimum\_trade\_size$, $increment$, and $available\_units$ for the fixed-income security.
Each of the T subsequent lines defines a portfolio order as two space-separated values; the first value is a string denoting the $portfolio\_identifier$, and the second value is an integer denoting the $portfolio\_order$.

Constraints

- $0 < T < 1000$
- $0 < increment < minimum\_trade\_size < available\_units$
- $portfolio\_order = minimum\_trade\_size + increment \times n$ for some non-negative integer, n.
- $minimum\_trade\_size \times number\ of\ portfolios < available\_units$

Output Format

Print T lines where each line contains two space-separated values: a $portfolio\_identifier$ followed by the number of units allocated to the portfolio. Your output must be ordered alphabetically by $portfolio\_identifier$.

Sample Input

```
2
10 2 40
p1 16
p2 134
```

Sample Output

```
p1 0
p2 40
```

Explanation

First, we have the following information about our fixed-income security:

- $minimum\_trade\_size = 10$
- $increment = 2$
- $available\_units = 40$

Next, we have $T = 2$ portfolio orders:

1. $p1$'s $portfolio\_order = 16$.
2. $p2$'s $portfolio\_order = 134$.

We can calculate $total\_order = 16 + 134 = 150$

$$p1\_proportional\_allocation = \frac{16}{16 + 134} \times 40 = 4.26$$

Because $p1\_proportional\_allocation < \frac{minimum\_trade\_size}{2} \implies 4.26 < 5$, nothing is allocated to $p1$. Therefore, all 40 $available\_units$ are allocated to $p2$.