A • Which Base is it Anyway?

Programming languages such as C++ and Java can prefix characters to denote the *base* of constant integer values. For example, hexadecimal (base 16) constants are preceded by the string "**0x**". Octal (base 8) values are preceded by the character "**0**" (zero). Decimal (base 10) values do not have a prefix. For example, all the following represent the same integer constant, albeit in different bases.

```
0x1234
011064
 4660
```

The prefix makes it clear to the compiler what base the value is in. Without the "**0x**" prefix, for example, it would be impossible for the compiler to determine if 1234 was hexadecimal. It could be octal or decimal.

For this problem, you will write a program that interprets a string of decimal digits as if it were an octal value, a decimal value or a hexadecimal value.

Input

The first line of input contains a single decimal integer ***P***, **(1** $\leq$ ***P*** $\leq$ **10000**), which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a single line of input. It contains the data set number, ***K***, followed by a single space, followed by a string of at most 7 decimal digits.

Output

For each data set there is one line of output. The single output line consists of the data set number, ***K***, followed by a space followed by 3 space separated decimal integers which are the value of the input as if it were interpreted to as octal, decimal and hexadecimal respectively. If the input value cannot be interpreted as an octal value, use the value 0.

Sample Input	Sample Output
4 1 1234 2 9 3 1777 4 129	1 668 1234 4660 2 0 9 9 3 1023 1777 6007 4 0 129 297

B • FBI Universal Control Numbers

The ***FBI*** has recently changed its *Universal Control Numbers* (*UCN*) for identifying individuals who are in the FBI's fingerprint database to an eight digit base 27 value with a ninth *check* digit. The digits used are:

```
0123456789ACDEFHJKLMNPRTVWX
```

Some letters are not used because of possible confusion with other digits:

```
B->8, G->C, I->1, O->0, Q->0, S->5, U->V, Y->V, Z->2
```

The *check* digit is computed as:

```
(2*D1 + 4*D2 + 5*D3 + 7*D4 + 8*D5 + 10*D6 + 11*D7 + 13*D8) mod 27
```

Where `Dn` is the n^{th} digit from the left.

This choice of *check* digit detects any single digit error and any error transposing an adjacent pair of the original eight digits.

For this problem, you will write a program to parse a *UCN* input by a user. Your program should accept decimal digits and *any* capital letter as digits. If any of the *confusing* letters appear in the input, you should replace them with the corresponding valid digit as listed above. Your program should compute the correct *check* digit and compare it to the entered check digit. The input is rejected if they do not match otherwise the decimal (base 10) value corresponding to the first eight digits is returned.

Input

The first line of input contains a single decimal integer ***P***, ($1 \le P \le 10000$), which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a single line of input. It contains the data set number, ***K***, followed by a single space, followed by 9 decimal digits or capital (alphabetic) characters.

Output

For each data set there is one line of output. The single output line consists of the data set number, ***K***, followed by a single space followed by the string "**`Invalid`**" (without the quotes) or the decimal value corresponding to the first eight digits.

Sample Input	Sample Output
3	1 11280469652
1 12345678A	2 Invalid
2 12435678A	3 Invalid
3 12355678A	

C • *m*-ary Partitions

A *partition* of an integer *n* is a set of positive integers which sum to *n*, typically written in descending order. For example:

```
10 = 4+3+2+1
```

A partition is *m*-ary if each term in the partition is a power of *m*. For example, the 3-ary partitions of 9 are:

```
9
3+3+3
3+3+1+1+1
3+1+1+1+1+1+1
1+1+1+1+1+1+1+1+1
```

Write a program to find the number of *m*-ary partitions of an integer *n*.

Input

The first line of input contains a single decimal integer ***P***, **(1 ≤ *P* ≤ 1000)**, which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a single line of input. The line contains the data set number, ***K***, followed by the base of powers, ***m***, **(3 <= m <= 100)**, followed by a space, followed by the integer, *n*, **(3 <= n <= 10000)**, for which the number of *m*-ary partitions is to be found.

Output

For each data set there is one line of output. The output line contains the data set number, ***K***, a space, and the number of *m*-ary partitions of *n*. The result should fit in a 32-bit ***unsigned*** integer.

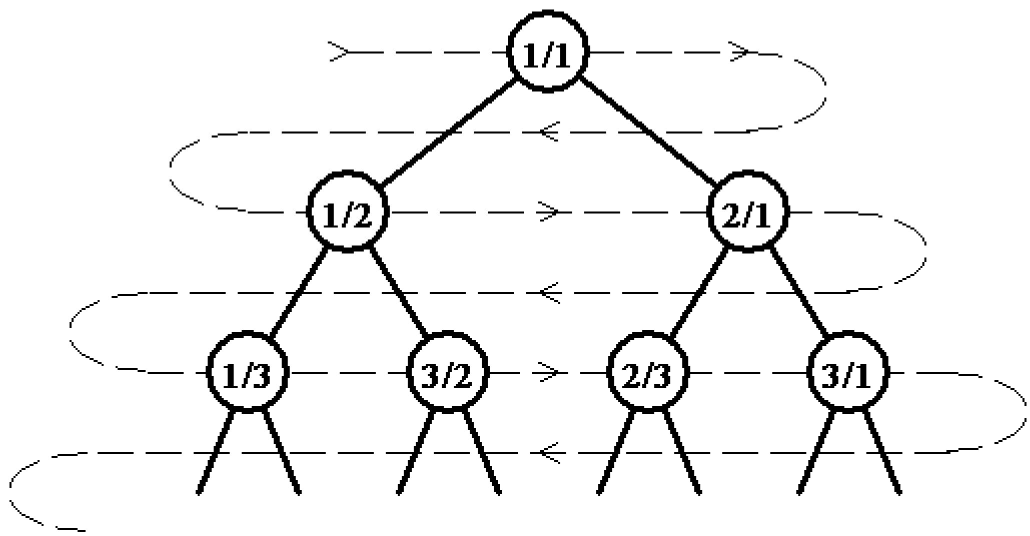
Sample Input	Sample Output
5 1 3 9 2 3 47 3 5 123 4 7 4321 5 97 9999	1 5 2 63 3 75 4 144236 5 111

D • A Rational Sequence (Take 3)

An infinite full binary tree labeled by positive rational numbers is defined by:

- The label of the root is `1/1`.
- The left child of label `p/q is p/(p+q)`.
- The right child of label `p/q` is `(p+q)/q`.

The top of the tree is shown in the following figure:



A rational sequence is defined by doing a level order (breadth first) traversal of the tree (indicated by the light dashed line). So that:

`F(1) = 1/1, F(2) = 1/2, F(3) = 2/1, F(4) = 1/3, F(5) = 3/2, F(6) = 2/3, …`

Write a program to compute the n^{th} element of the sequence, `F(n)`. Does this problem sound familiar? Well it should! We had variations of this problem at the 2014 and 2015 Greater NY Regionals.

Input

The first line of input contains a single integer ***P***, (**1 ≤ *P* ≤ 1000**), which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a single line of input. It contains the data set number, ***K,*** and the index, ***N***, of the sequence element to compute (**1 <= *N* <= 2147483647**).

Output

For each data set there is a single line of output. It contains the data set number, ***K***, followed by a single space which is then followed by the numerator of the fraction, followed immediately by a forward slash ('/') followed immediately by the denominator of the fraction. Inputs will be chosen so neither the numerator nor the denominator will overflow an 32-bit ***unsigned*** integer.

Sample Input	**Sample Output**
4 1 1 2 4 3 11 4 1431655765	1 1/1 2 1/3 3 5/2 4 2178309/1346269

E • Permutation Descent Counts

Given a positive integer, ***N***, a *permutation* of order ***N*** is a one-to-one (and thus *onto*) function from the set of integers from **1** to ***N*** to itself. If ***p*** is such a function, we represent the function by a list of its values:

$$[\, p(1)\ \ p(2) \ldots \mathbf{p}(N)\,]$$

For example,

[**5 6 2 4 7 1 3**] represents the function from { **1 … 7** } to itself which takes **1** to **5**, **2** to **6**, … , **7** to **3**.

For any permutation ***p***, a *descent* of ***p*** is an integer ***k*** for which ***p***(***k***) > ***p***(***k***+**1**). For example, the permutation [**5 6 2 4 7 1 3**] has a descent at **2** (**6** > **2**) and **5** (**7** > **1**).

For permutation ***p***, ***des***(***p***) is the number of descents in ***p***. For example, ***des***([**5 6 2 4 7 1 3**]) = **2**. The *identity* permutation is the only permutation with ***des***(***p***) = 0. The *reversing* permutation with ***p***(***k***) = ***N***+**1**-***k*** is the only permutation with ***des***(***p***) = **N-1**.

The *permutation descent count* (*PDC*) for given order ***N*** and value ***v*** is the number of permutations ***p*** of order ***N*** with ***des***(***p***) = ***v***. For example:

PDC(**3, 0**) = **1** { [**1 2 3**] }
PDC(**3, 1**) = **4** { [**1 3 2**], [**2 1 3**], [**2 3 1**], **3 1 2**] }
PDC(**3, 2**) = **1** { [**3 2 1**] }

Write a program to compute the *PDC* for inputs ***N*** and ***v***. To avoid having to deal with very large numbers, your answer (and your intermediate calculations) will be computed **modulo 1001113**.

Input

The first line of input contains a single integer P, $(1 \le P \le 1000)$, which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a single line of input. It contains the data set number, ***K*,** followed by the integer order, N $(2 \le N \le 100)$, followed by an integer value, v $(0 \le v \le \mathbf{N\text{-}1})$.

Output

For each data set there is a single line of output. The single output line consists of the data set number, K, followed by a single space followed by the *PDC* of N and v ***modulo*** **1001113** as a decimal integer.

Sample Input	Sample Output
4 1 3 1 2 5 2 3 8 3 4 99 50	1 4 2 66 3 15619 4 325091

F • Tight-Fit Sudoku

At some point or another, most computer science students have written a standard Sudoku solving program. A slight twist has been added to standard Sudoku to make it a bit more challenging.

Digits from 1 to 9 are entered in a 6x6 grid so that no number is repeated in any row, column or 3x2 outlined region as shown below. Some squares in the grid are split by a slash and need 2 digits entered in them. The smaller number always goes above the slash.

/	/5	4	3	2	/
	6	/	/		/
	7/		/	/	2
8	/	/		/3	
/		/	/	4	
/	8	7	6	5/	/

Incomplete Grid

7/9	1/5	4	3	2	6/8
3	6	2/8	1/9	7	4/5
1	7/9	3	4/5	6/8	2
8	2/4	5/6	7	1/3	9
5/6	3	1/9	2/8	4	7
2/4	8	7	6	5/9	1/3

Solution Grid

For this problem, you will write a program that takes as input an incomplete puzzle grid and outputs the puzzle solution grid.

Input

The first line of input contains a single decimal integer ***P*, (1 ≤ *P* ≤ 100)**, which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of 7 lines of input. The first line of the data set contains the data set number, ***K.*** The remaining 6 lines represent an incomplete Tight-Fit Sudoku grid, each line has 6 *data elements*, separated by spaces. A *data element* can be a digit (1-9), a dash (‘-‘) for a blank square or two of these separated by a slash (‘/’).

Output

For each data set there are 7 lines of output. The first output line consists of the data set number, ***K***. The following 6 lines of output show the solution grid for the corresponding input data set. Each line will have 6 *data elements,* separated by spaces. A *data element* can be a digit (1-9), or 2 digits separated by a slash (‘/’).

Sample Input	Sample Output
1	1
1	7/9 1/5 4 3 2 6/8
-/- -/5 4 3 2 -/-	3 6 2/8 1/9 7 4/5
- 6 -/- -/- - -/-	1 7/9 3 4/5 6/8 2
- 7/- - -/- -/- 2	8 2/4 5/6 7 1/3 9
8 -/- -/- - -/3 -	5/6 3 1/9 2/8 4 7
-/- - -/- -/- 4 -	2/4 8 7 6 5/9 1/3
-/- 8 7 6 5/- -/-	

G • Magical Mystery Knight's Tour

A knight's tour on a rectangular board of ***n*** rows and ***m*** columns of squares (traditionally 8-by-8) is a labelling of the squares by integers ***1*** through ***n*m*** so that label (***n+1***) is a knight's move from label ***n***. That is, ***2*** squares horizontally and ***1*** square vertically or ***1*** square horizontally and ***2*** squares vertically. The image below shows an 8-by-8 knight's tour.

1	56	13	26	3	46	15	28
24	37	2	57	14	27	4	47
55	12	25	38	45	58	29	16
36	23	64	61	42	39	48	5
11	54	41	44	59	62	17	30
22	35	60	63	40	43	6	49
53	10	33	20	51	8	31	18
34	21	52	9	32	19	50	7

A knight's tour (on a square board) is (*semi*-)magical if the sum of the values in each row and column is the same (for the 8-by-8 case the sum would be 260). For this problem, you will be given a sequence of semi-magical 8-by-8 knight's tours with many of the labels removed (see the image below). Write a program to fill in the missing labels so the knight's tour is *semi*-magical.

1	48			33		63	18
30	51		3				
				15			
			45			36	
		25		9		21	60
				24	57	12	
	6			39			
54		42					

Input

The first line of input contains a single decimal integer ***P***, (1 ≤ ***P*** ≤ 10000), which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a multiple lines of input. The first line of each data set contains the data set number, ***K.*** This line is followed by 8 lines each containing 8 integers separated by spaces giving the labels for the corresponding row. If the label value is **-1**, the label has been removed and your program is to find the correct value to put in that place.

Output

For each data set there are 9 lines of output. The first output line contains the data set number, ***K***. The following 8 lines should contain 8 integers each, separated by spaces, filling in the removed values to give a complete semi-magical knight's tour which includes the positive labels from the input. There may be multiple correct answers. Your result will be graded correct if it is a semi-magical knight's tour and the positive labels from the input are in the same square in your answer.

Sample Input	Sample Output
1	1
1	1 48 31 50 33 16 63 18
1 48 -1 -1 33 -1 63 18	30 51 46 3 62 19 14 35
30 51 -1 3 -1 -1 -1 -1	47 2 49 32 15 34 17 64
-1 -1 -1 -1 15 -1 -1 -1	52 29 4 45 20 61 36 13
-1 -1 -1 45 -1 -1 36 -1	5 44 25 56 9 40 21 60
-1 -1 25 -1 9 -1 21 60	28 53 8 41 24 57 12 37
-1 -1 -1 -1 24 57 12 -1	43 6 55 26 39 10 59 22
-1 6 -1 -1 39 -1 -1 -1	54 27 42 7 58 23 38 11
54 -1 42 -1 -1 -1 -1 -1	

Note: *Your output does not have to be lined up as shown in the Sample Output above. Just make sure that each of the 8 lines of output for each data set has at least one space, but no more than two spaces between each value on the line.*

H • DA-Sort

You recently learned a new way to sort an array of numbers in your algorithms course. The algorithm sorts an array of numbers by repeatedly performing the *Delete-and-Append* operation. The *Delete-and-Append* operation consists of three steps:

1) Choose an element from the array.
2) Delete the chosen element from the array.
3) Append the chosen element to the end of the array.

Being a curious student, you wonder what is the minimum number of *Delete-and-Append* operations required to sort a given array.

Input

The first line of input contains a single decimal integer P, ($1 \leq P \leq 100$), which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of two or more lines of input. The first line contains the data set number, K, followed by a single space, followed by an integer N, ($1 \leq N \leq 1000$), which is the length of the array to sort. The remaining lines in the dataset contains N positive integers that comprise the array to be sorted, 10 values per line, except for the last line which may have less than 10 values. All the array elements are no larger than 10^9. The same value may appear more than once in the array to be sorted.

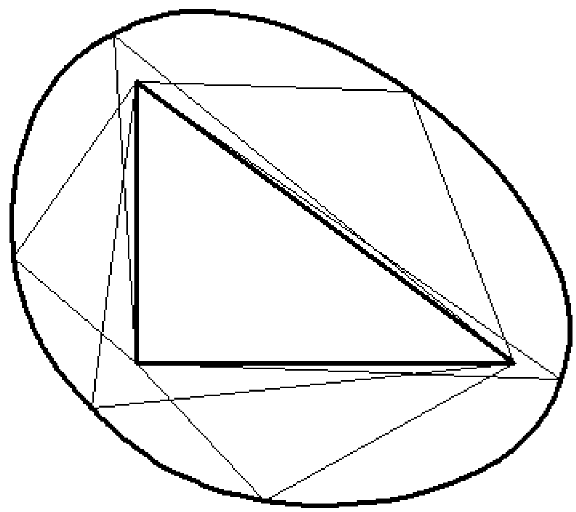
Output

For each data set there is one line of output. The single output line consists of the data set number, K, followed by a single space followed by an integer which is the minimum number of *Delete-and-Append* operations required to sort the array.

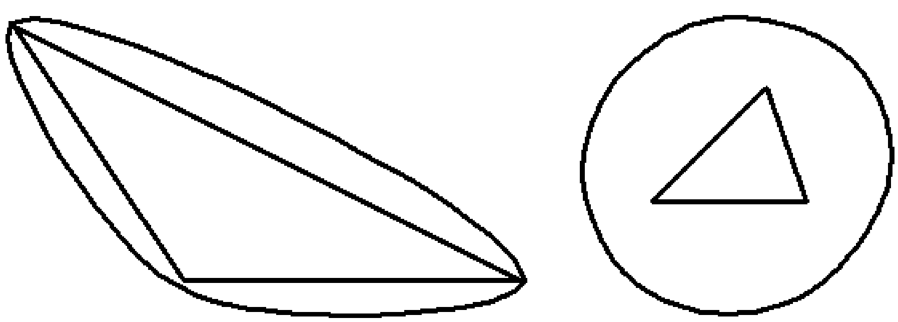
Sample Input	Sample Output
3 1 3 1 3 2 2 6 1 5 2 4 3 6 3 23 67890 56312 999999999 12345 23456 38927 45632 100345 98765 23456 87654 43278 23456 117654 321899 25432 54326 217435 26845 31782 33456 41234 56213	1 1 2 3 3 15

J • Smoothed Gardens

The *Flathead Fancy Landscaping Company's* customers are too high-class to have gardens with straight edges so Joe P. Flathead, the owner, has come up with a way to smooth out the contours. He puts a stake in each corner of a triangular plot and drops a loop of rope around the three stakes. Then using a fourth stake in the loop, he pulls the rope tight to mark out a smoothed version of the triangle (see the figure below, the thinner lines are various positions of the rope). This process is similar to the method you learned in middle school to draw an ellipse using 2 push-pins, a piece of string and a pencil, but J.P. Flathead is using *three* stakes (not two), a rope and another stake instead of a pencil.



The longer the rope loop, the smoother the outline will be (see the examples below):



In order to determine how much soil and how many plants are required for the garden, Joe needs to find out the area of the resulting smoothed outline.

For this problem you will write a program which takes as input the coordinates of the corners of the triangle and the length of the rope loop and outputs the area of the smoothed region. The coordinate system will be chosen so that the first vertex is at the origin (`A(0, 0)`), the *x*-axis is along the line from the first vertex to the second vertex (B(B_x, 0)) and the final vertex is above the *x*-axis

(C(Cx, Cy)).

Input

The first line of input contains a single decimal integer ***P***, ($1 \le P \le 10000$), which is the number of data sets that follow. Each data set should be processed identically and independently.

Each data set consists of a single line of input. It contains the data set number, ***K***, followed by a single space, followed by 4 floating point values B_x, C_x, C_y, ($B_x > 0$, $C_y > 0$), and the rope length L all measured in feet.

Output

For each data set there is one line of output. The single output line consists of the data set number, ***K***, followed by a single space followed by the area of the smoothed region in square feet accurate to 2 decimal places.

Sample Input	Sample Output
3	1 23.49
1 4 0 3 13	2 37.46
2 3 -2 3 14.5	3 42.24
3 4 3 3 14	