

UCF Local Contest — September 2, 2006

Crystal Etching (filename: etch)

When one usually thinks of crystals, they think of chandeliers and other ornamental items. Yet, there are crystals that are components in our every day appliances, such as microwaves. These crystals have to be produced at very specific thicknesses to obtain the desired frequency of oscillation. Part of this process involves creating a generic crystal that is too thick, and then calculating exactly how long that crystal needs to be placed in a chemical etch bath to reduce it to the proper thickness. In particular, if the current frequency of oscillation of a crystal is f_1 , and its target frequency is f_2 , then t , the number of seconds necessary to etch the crystal to achieve the desired frequency satisfies the following equation:

$$\frac{f_2 - f_1}{f_1 f_2} = at + b(1 - e^{-ct})$$

where a , b , and c are all dependent upon the actual chemical composition of the etch bath. (Note: The units of frequency are 1/sec.)

The Problem:

Given the current frequency of a crystal (f_1), its target frequency (f_2), and the values of a , b , and c , for a particular etch bath, calculate the amount of time (t , in seconds), rounded to the nearest hundredth that is necessary to etch the crystal to obtain its desired frequency.

The Input:

The first line of the input file will contain a single positive integer n , the number of test cases in the file. Each of the next n input lines will contain information for a single test case. On each line, the following values, all positive real values, will be separated by spaces: f_1 , f_2 , a , b , and c . It is guaranteed that $100000 \geq f_2 > f_1 \geq 10$.

The Output:

For each input case, print a heading followed by the number of seconds (rounded to the nearest hundredth) necessary to etch the corresponding crystal to achieve its target frequency. Assume that no etch time will exceed 1000000.00 seconds. Leave a blank line after the output for each data set. Follow the format illustrated in Sample Output.

(Sample Input/Output on the next page)

Sample Input:

2
500 1000 .001 .001 1
1000 2000 .00025 .0005 .6931472

Sample Output:

Crystal #1: 0.57
Crystal #2: 1.00