

COP 3502H – Spring 2012
Problem Solving Day -- Mortgage Payments
Due on Webcourses, Friday 2/17, by 11:55pm

Problem:

When buying a new home, the buyer often takes out a loan to pay for it (unless you're a baller!). In this problem, we will be considering loans with the following terms:

- At the beginning of each month, the buyer pays a fixed amount towards the loan, which decreases the amount they owe.
- At the end of the month, the amount the purchasers owe increases due to interest. Each month, 1/12 of the annual interest rate is added to the amount owed. Hence, if the annual interest rate is 12%, then the debt increases by 1% each month. You may assume that the amount owed after adding interest is always rounded up to the nearest dollar greater than or equal to the actual value.

Your task is, given the annual *interest* rate in tenths of a percent, the original amount of the *loan*, and the period over which the loan is to be repaid, calculate the minimum integral monthly payment so that the loan is repaid in *term* years or less. All monetary units are in dollars.

Example:

If *loan* = 1000, *interest* = 50, and *term* = 1, then the loan is for \$1000, at an annual interest rate of 5%, or (5/12)% per month. If the buyer pays back \$86 every month, then the total amount owed will be as follows after each month:

<u>Month</u>	<u>After making payment</u>	<u>After interest accrues</u>
1	$1000 - 86 = 914$	$\text{ceil} (914 * (1 + 5/12/100)) = 918$
2	$918 - 86 = 832$	$\text{ceil} (832 * (1 + 5/12/100)) = 836$
3	$836 - 86 = 750$	754
4	$754 - 86 = 668$	671
5	$671 - 86 = 585$	588
6	$588 - 86 = 502$	505
7	$505 - 86 = 419$	421
8	$421 - 86 = 335$	337
9	$337 - 86 = 251$	253
10	$253 - 86 = 167$	168
11	$168 - 86 = 82$	83
12	86 is more than enough to pay off the rest	

Clearly, \$85 a month wouldn't be enough, since we just barely paid off the loan at \$86.

Constraints:

- *loan* will be between 100 and 2,000,000,000 inclusive.
- *interest* will be between 1 and 1,000,000 inclusive.
- *term* will be between 1 and 1000 inclusive.

Deliverables:

Mortgage.c
 Experimental results.

Implementation:

You must use **binary search** to converge at the minimum integral monthly payment.

Hint: let low = 0, high = INT_MAX, if the loan can be paid with mid as the monthly payment decrease high, otherwise increase low.

Suggested Resources: math.h, limits.h

Input File Format (mortgage.in):

Your program should read from a file mortgage.in. The file will contain an integer *n* denoting the number of test cases, followed by *n* lines containing *loan interest term*.

Output File Format (mortgage.out): The output file will contain *n* lines with each of the determined monthly payments for each test case.

Example Input File:

```
5
1000 50 1
2000000000 6000 1
1000000 1000000 1000
1000000 129 30
1999999999 1000000 1
```

Example Output File:

```
86
671844808
988143
10868
1976284585
```

Experimental Results:

Time your algorithm using the given input files: Mortgage_1000.in, Mortgage_2000.in, Mortgage_4000.in, Mortgage_8000.in.

Fill in the following table and comment on your results using a few sentences.

Theoretical Analysis: _____

n	T(n)	F(n)	T(n)/F(n)
1000			
2000			
4000			
8000			