2008 Paper 1 Question 9

Programming in Java

(a) Show how you would create a Java array of 1000 integer values. [1 mark]

(b) The values in an array could be used to represent digits in the decimal representation of a number. For example, the number $\frac{1}{7}$ has decimal representation $0.142857\ldots$ and that could be stored in an array whose elements started $\{1, 4, 2, \ldots\}$. For a number stored that way write code that multiplies the number by a given integer, returning the whole number part of the result and leaving the array updated to hold the fractional part of the product.
[5 marks]

(c) To convert a fraction to a representation base 16 (i.e. hexadecimal) you can multiply it by 16, and the resulting integer part is the first digit of the base-16 representation. Multiplying the fraction left over by 16 gets the second digit and so on. Write a method that accepts an array of digits (base 10) and creates and returns a new array representing the same fraction but now base 16. Your code should work for any length input array, not just one of length 1000, and you may make the output array have the same length as your input array.
[6 marks]

(d) Suppose the input to your method in part (c) was of length 1000 and started off with the decimal digits of $\frac{1}{7}$ in it. Although the initial digits in the output array are the correct hexadecimal representation of $\frac{1}{7}$ the last few end up looking odd. Explain. [3 marks]

(e) One way to ensure that numerical results are correct is to use *interval arithmetic*. A value is represented as a pair of arrays, one representing a number less than (or equal to) the true value and one a value greater than it. So if using 6 decimal places the number $\frac{1}{7}$ would be held as a pair $\{142857, 142858\}$. If the two final digits differ by at most 1 then the smaller of them can be viewed as fully accurate. Using this idea, write code that accepts a fraction in decimal form and returns a vector denoting the same value in another base n (now no longer necessarily 16) such that all the digits in the result vector are correct. Clarity in your code is to be preferred to performance, but if you are aware of particular ways in which the code you present is particularly inefficient, you should note and explain them.
[5 marks]