Theory of Algorithms

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1. An array of n elements contains all integers from 0 to n except one. Design a O(n) time algorithm that determines the missing number. Your algorithm must only use O(1) amount of space in addition to A (so no auxiliary array is allowed).

Justify the running time of your algorithm.

2. What would be the best algorithm for finding a number that occurs only once in a list which has all other numbers occurring exactly twice?

Consider the following example: 2, 1, 5, 1, 8, 5, 2  
Design a O(n) time algorithm.

3. Construct an example for which Quicksort will use (n2) comparisons when the pivot is chosen by taking the median of the first, last, and middle elements of the sequence. The elements of your sequence must be all distinct.