Problem 2

a) The worst case is that in each recursion depth, we have n elements to be sorted (i.e. will not end because only one element in the group). And the maximum number of digits is the same number of digits of n^2, which should be $\Theta(\log_{10} n^2) = \Theta(\log n)$. And the assume the radix is a constant, then the total runtime for worst-case should be $\Theta(n \log n) \in o(n^2)$

b) The best case is that all $\sqrt{k}$ patterns are found at the beginning of the text.

   For the first guess, it cost $\Theta(\sqrt{k} \cdot m + k\text{-}\sqrt{k}) = \Theta(k + \sqrt{k} \cdot m)$

   For the rest guesses, each costs $\Theta(k - \sqrt{k}) = \Theta(k)$

   Therefore, totally, we have n-m+1 guesses, which is $\Theta(n)$

   So the best-case expected runtime is $\Theta(nk + \sqrt{k} \cdot m) = \Theta(nk)$

   The worst case is that for each guess, the hash value matches, and we need do a strcmp() for each pattern. And finally, we will find the matched pattern in the last guess.

   For every guesses, each cost $\Theta(k \cdot m)$, similar to the best case, we have $\Theta(n)$ guesses in total. Therefore, the worst-case runtime is $\Theta(nkm)$