Problem 1.

314, 512, 004, 999, 023, 042, 613, 109, 001, 123, 666

a) 314, 512, 004, 999, 023, 042, 613, 109, 001, 123, 666
004, 314, 512, 999, 023, 042, 613, 109, 001, 123, 666
004, 314, 512, 999, 023, 042, 613, 109, 001, 123, 666
004, 023, 314, 512, 999, 042, 613, 109, 001, 123, 666
004, 023, 042, 314, 512, 999, 613, 109, 001, 123, 666
004, 023, 042, 314, 512, 613, 999, 109, 001, 123, 666
004, 023, 042, 109, 314, 512, 613, 999, 001, 123, 666
001, 004, 023, 042, 109, 314, 512, 613, 999, 123, 666
001, 004, 023, 042, 109, 123, 314, 512, 613, 999, 666
001, 004, 023, 042, 109, 123, 314, 512, 613, 666, 999

b) 004, 023, 042, 109, 001, 123 || **314** || 512, 999, 613, 666
004, 023, 001 || **042** || 109, 123 512, 613 || **666** || 999
001 || **004** || 023 109, 123 512, 613
001, 004, 023, 042, 109, 123, 314, 512, 613, 666, 999

c) 001, 512, 042, 023, 613, 123, 314, 004, 666, 999, 109
001, 004, 109, 512, 613, 314, 023, 123, 042, 666, 999
001, 004, 023, 042, 109, 123, 314, 512, 613, 666, 999

Problem 2.

a) You are extending every key K, to be the pair <K, I> where I is an integer denoting the number of times that K has been added before. When you compare keys now, first compare using K; if they are equal compare using I.

b) 2,1,3,4,1 Consider this list of keys. The pivot will be 2 and so the 2 will be swapped with the last 1. Now the key 1 that was added last is at the front of the list and will never be moved again in the sorting. Thus quicksort is not stable.

Problem 3.

This runs in O(N) time because every merge of the same size subarray happens at the same time. The runtime of merge is the sum of the runtimes of merging one subarray of each size from 1 to N/2. Since merging k elements takes O(k) time, this means the total runtime is $O(1)+\ldots+O(N/2)=O(N)$.