2. What is the running time of Insertion sort if all elements are equal?

Algorithme 1 Insertion Sort

```
Insertion-Sort(a) :
for j = 1 :len(A)
    key = a[j]
    i = j - 1
    while i > 0 and A[i] > key
        A[i + 1] = A[i]
        i = i - 1
    A[i + 1] = key
```

Since the array is sorted the algorithm never enters the while loop and thus does a constant amount of work per iteration, we denote this constant c. $\sum_{i=1}^{n} c = n \cdot c = \Theta(n)$.

5. What is the worst-case running time of Quicksort if the pivot is randomly chosen as the first element in the array in each recursive call?

We assume that the array is sorted. If so then the first element chosen is the smallest. This leads to the left-subproblem having no elements and the right subarray having $n - 1$ elements. This is of the form $T(n) = T(n - 1) + O(n)$, which solves to $O(n^2)$.