Heapsort (7 points)

1. [2 points] What is the running time of heapsort on an array A of length n that is already sorted in increasing order? What about decreasing order?

2. We can build a heap by repeatedly calling MAX-HEAP-INSERT to insert the elements into the heap. Consider the following variation on the BUILD-MAX-HEAP procedure:

   BUILD-MAX-HEAP′ (A)
   1. $A.heap\text{-}size = 1$
   2. for $i = 2$ to $A.length$
   3. MAX-HEAP-INSERT$(A, A[i])$

   (a) [2 points] Do the procedures BUILD-MAX-HEAP and BUILD-MAX-HEAP′ always create the same heap when run the same input array? Prove that they do, or provide a counterexample.

   (b) [3 points] Show that in the worst case, BUILD-MAX-HEAP′ requires $\Theta(n \lg n)$ time to build an n-element heap.