1. A priority queue has the same operations as a regular queue, except the items are NOT returned in the FIFO (first-in, first-out) order. Instead, each item has a priority that determines the order they are removed. A hospital emergency room operates like a priority queue -- the person with the most serious injury has highest priority even if they just arrived.

a) Suppose that we have a priority queue with integer priorities such that the smallest integer corresponds to the highest priority. For the following priority queue, which item would be dequeued next?

priority queue:

40 10 79
30 13

b) To implement a priority queue, we could use an unordered Python list. If we did, what would be the worst-case theta (Θ( )) notation for each of the following methods: (justify your answer)

• enqueue:
• dequeue:

c) To implement a priority queue, we could use a linked list ordered by priorities, e.g., the LinkedPriorityQueue class of chapter 15. If we did, what would be the worst-case theta (Θ( )) notation for each of the following methods: (justify your answer)

• enqueue:
• dequeue

2. Sections 18.9 - 18.11 discuss a very “non-intuitive”, but powerful list/array-based approach to implement a priority queue, call a heap. The list/array is used to store a complete binary tree (a full tree with any additional leaves as far left as possible) with the items being arranged by heap-order property, i.e., each node is less than either of its children. An example of a min heap “viewed” an a complete binary tree would be:

```
6
/    /
15  10
/  /
114 20
/  /  
300 125 117
```

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a) For the above heap, the list/array indexes are indicated in [ ]'s. For a node at index \( i \), what is the index of:
- its left child if it exists:
- its right child if it exists:
- its parent if it exists:

b) What would the above heap look like after adding 13 and then 8?

c) What is the worst-case theta (\( \Theta() \)) notation for adding a new item in the heap?

d) What is the worst-case theta (\( \Theta() \)) notation for removing the smallest item from the heap?