Tree review

complete tree

- if it has height **h** the number of nodes is _____
- if it has **N** nodes, the number of leaves (nodes on the last level) is _____
- if it has N nodes, if each leaf keeps swapping with its parent, until it gets to the root, then one leaf will do _____ swaps and all leaves together will do _____ swaps.

nearly complete tree

- if it has height **h** the number of node N is: ____ ≤ N ≤ _____
- if it has **N** nodes, the height is _____
- if it has **N** nodes, the longest path has length _____
- if it has N nodes, the number of leaves is _____

Array traversal using

- idx = idx/2

```
for(idx = N; idx >= 1; idx = idx/2)
```
// repeats _____

- left = idx*2, right = idx*2+1

```
for(idx = 1; idx <= N; idx = idx*2)
```
// repeats _____

```
for(idx = 1; idx <= N; idx = idx*2+1)
```
// repeats _____

Priority Queues/Heaps:

What is a priority queue or a max-heap?

Uses:

Necessary operations:

Visualizing Heaps in Tree Format:

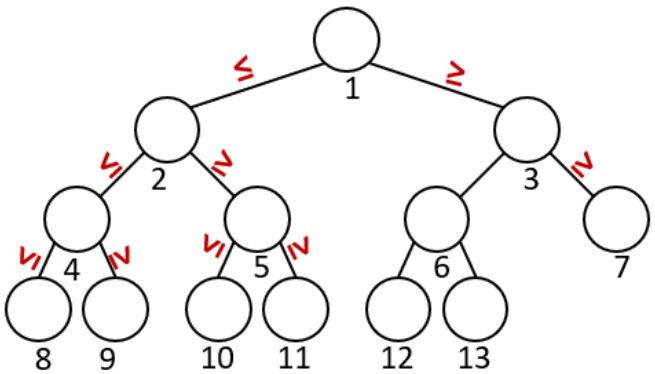
Drawing out heaps as a tree can make it much easier to understand the relationship certain elements have with each other based on the indexes they are stored at. However, note that a heap is NOT a _____. It is an _____ .

Required Tree Properties for a Max-Heap:

- Order of the Elements
  - Values at children indexes/nodes are _____ than values at their parent indexes/nodes
  - Items must respect order only along _____. Nodes in 2 subtrees have _____
- Shape of the Tree
  - The tree is a _____
  - There are no _____
  - All levels are complete but possibly the _____
  - If not complete, all nodes are to the _____ on the last level

Ex: Heap array

value	-	**9**	**7**	**5**	**3**	**5**	**4**	**3**	**2**	**1**	**1**	**3**	**4**	**1**
index	0	1	2	3	4	5	6	7	8	9	10	11	12	13



Index computation when 1st item is at index 1 (root is at index 1)

```
int left(int idx)     {return  idx*2     ;}
int right(int idx)    {return (idx*2)+1  ;}
int parent(int idx)   {return  idx/2     ;}
E.g.:
left(4)   -> _____
right(4)  -> _____
parent(4)-> _____
left(5)   -> _____
right(5)  -> _____
parent(5)-> _____
```

Inserting New Item:

1.) Increase size of array and add a new element to end
2.) Continually compare and swap new element with elements at the parent indexes until heap order is correct again (Perform swimUp())

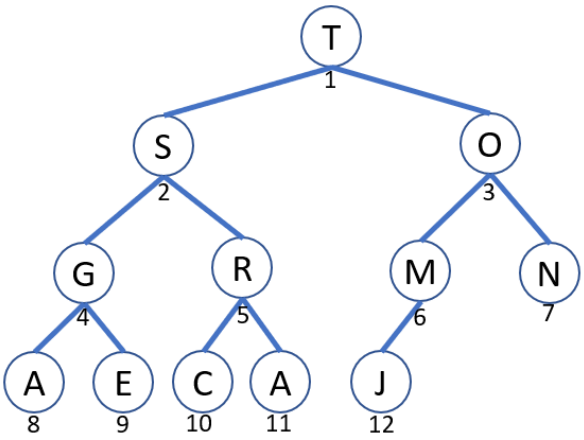
```
swimUp(int* A, int idx){




}
```

TC:

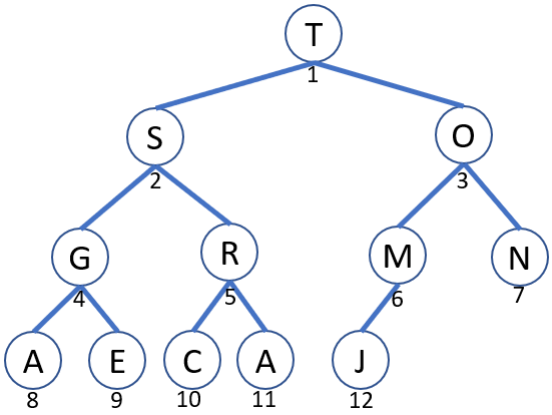
SC:

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z

Original Heap:



Add _____. Show the new heap below and affected/swapped elements on the original heap to the left.



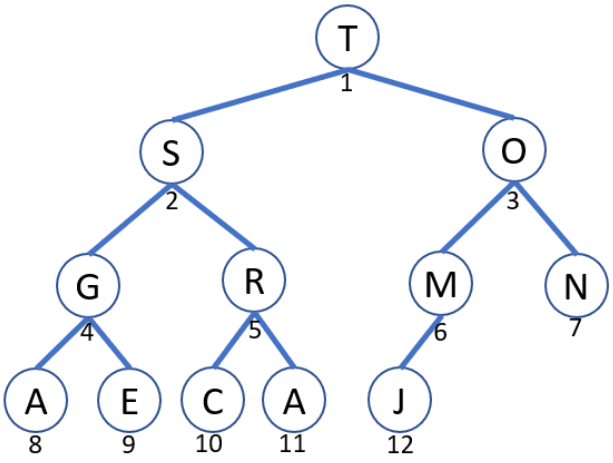
Remove() - will remove the top item

1.) Swap the first element in the array with the last element in the array
2.) Reduce the size of the array being dealt with (This is done not by physically altering the array but by altering the size input provided to the function so the last element in the array is ignored)
3.) Continually compare and swap the new element at the beginning of the array with the element at one of the children indexes which has the largest value until heap order is correct again (Perform sinkDown())
4.) Return the element stored at the end of the array

TC: _____ SC: _____
int idxOfMaxValue(int* A,int p,int le,int ri,int N){
 	
}
	TC: _____ SC: _____
	sinkDown(int* A, int p, int N){
	
	}

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z

Original Heap:



Remove _____. Show the new heap below and affected/swapped elements on the original heap t the left.

Batch Initialization of Heap:

- Bottom Up Batch: Turns an array into a heap by reordering its elements to fit requirements for heap order

  buildMaxHeap(int* A, int N) {

  }

  TC:

  SC:

- Top Down Batch: Builds a heap by **repeated insertions** in an originally empty heap

TC:

SC:

Heapsort:

Implementation:

Code:

Heapsort(int* A,int N){

}

TC:

SC:

Stable? _____ Adaptive? _____

Index	0	1	2	3	4	5
Original Array						
Heap						
Removal 1						
Removal 2						
Removal 3						
Removal 4						
Removal 5						

Variations:

What are the required adjustments to create a min heap instead of a max heap?

When would it be better to use a min-heap?

Index calculation

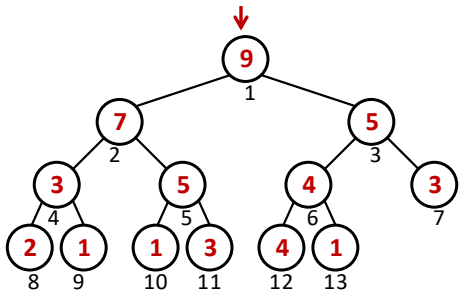
Index computation when 1st item is *at index 1 (root is at index 1)*

```
int left(int idx) {return     idx*2 ;}
int right(int idx) {return (  idx*2)+1 ;}
int parent(int idx) {return   idx/2 ;}
E.g.:
left(4)  -> ___
right(4) -> ___
parent(4)-> ___

left(5)  -> ___
right(5) -> ___
parent(5)-> ___
index of 1st item: _____
index of last item (based on size N): _____
```

Index computation when 1st item is *at index 0 (root is at index 0)*

```
int left(int idx) {return (   idx*2)+1 ;}
int right(int idx) {return (  idx*2)+2 ;}
int parent(int idx) {return (idx -1)/2 ;}
E.g.:
left(4)  -> ___
right(4) -> ___
parent(4)-> ___

left(5)  -> ___
right(5) -> ___
parent(5)-> ___
index of 1st item: _____
index of last item (based on size N): _____
```

value	-	9	7	5	3	5	4	3	2	1	1	3	4	1
index	0	1	2	3	4	5	6	7	8	9	10	11	12	13



value	9	7	5	3	5	4	3	2	1	1	3	4	1
index	0	1	2	3	4	5	6	7	8	9	10	11	12