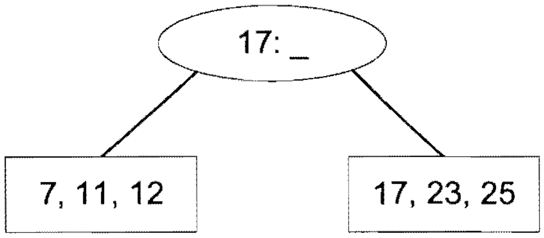
Department of Computer Science,
Data Structures (CSC212),
Tutorial 8
Autumn Semester 1427-28H

Instructors: Dr. Inayatullah Shah, Prof. Mohamad Batouche

Question 1



Shown above is an order 3 B+-tree. Perform the following operations on the tree.

(a) Insert the key 13 and show the resulting tree.
(b) Insert the key 27 and show the resulting tree.
(c) Insert the keys 14, 15 and show the resulting tree.
(d) Insert the keys 4, 5 and show the resulting tree.
(e) Delete the key 17 and show the resulting tree.

Question 2.

(a) Construct a heap from the following sequences of integers: 80, 70, 60, 50, 40, 30, 20, and 10.
(b) How many swaps and how many compares are required to construct a heap if the original data is (i) in sorted order (ii) already a heap (iii) in the inverse sorted order.

Question 3.

(a) Enqueue the following elements with the priority shown, into priority queue implemented as a heap: 10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13, and 2. Assume a lower number indicates higher priority.
(b) In the above priority queue perform three Dequeue (Serve) operations and show the queue.
(c) Enqueue the following elements into priority queue implemented as a heap: 20, 10, 13, 13, 11, 17, 12, 11, 15 and 11. Comment on the possibility of inserting elements with the same priorities into the priority queue.

Question 4.
Implement heap sort.

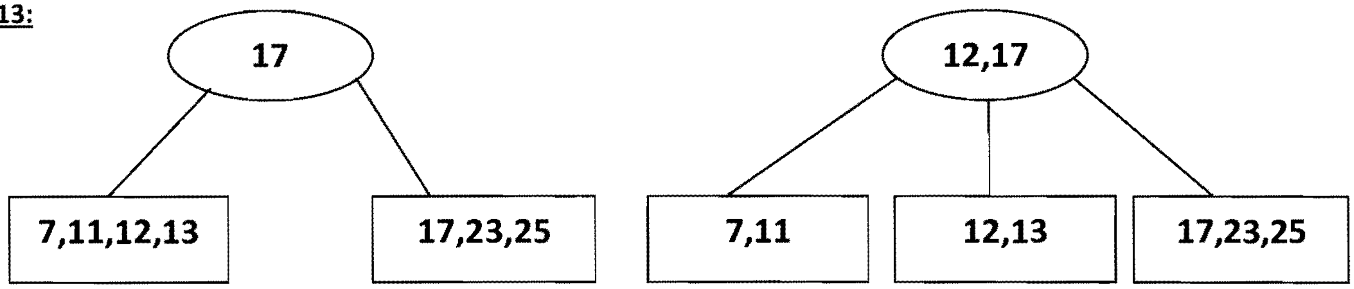
Question 5.

(a) Can a BST satisfy heap conditions? Give an example if yes.
(b) Can an AVL tree satisfy heap conditions? Give an example if yes.
(c) Can we implement a priority queue as a BST? Why or why not?

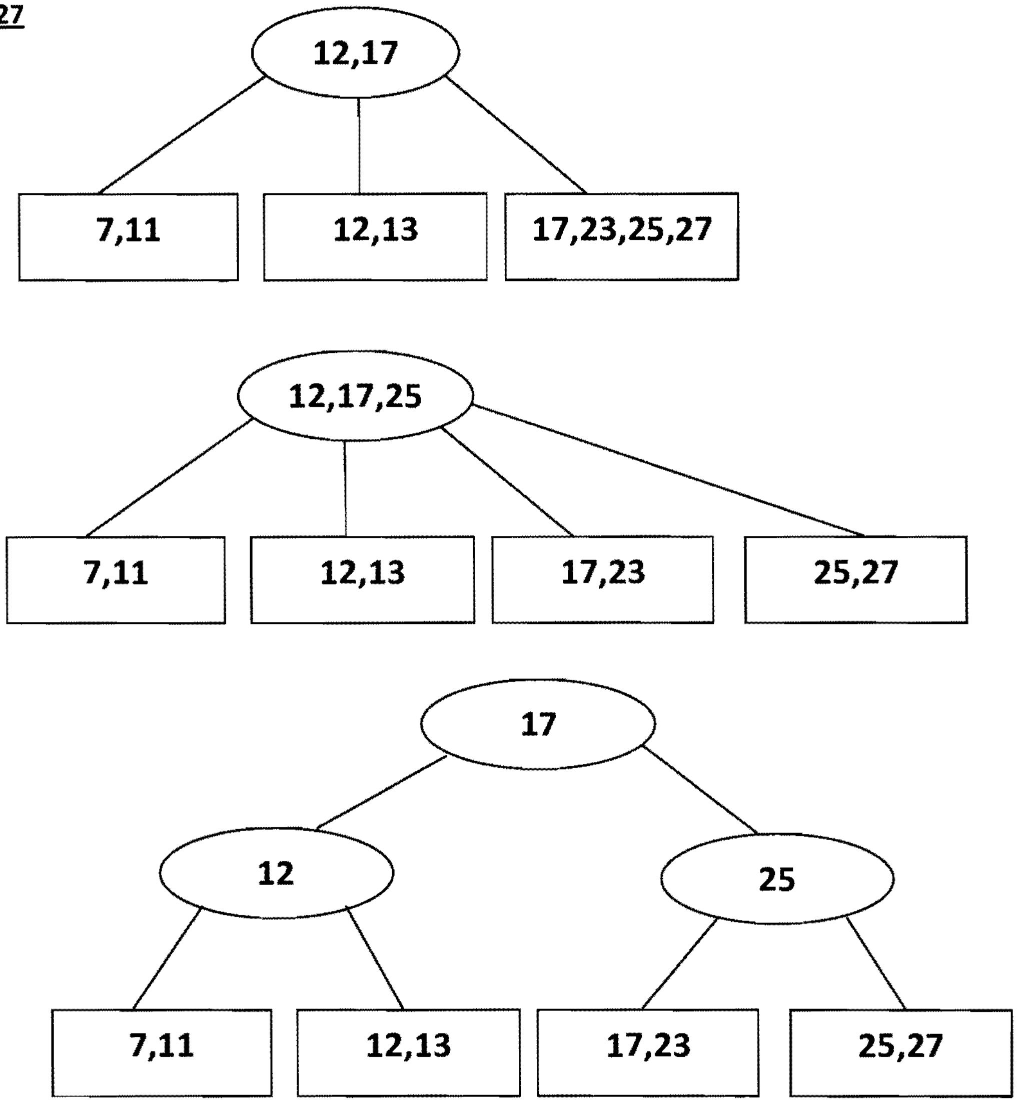
Q1

B+ Tree with order 3:

Insert 13:

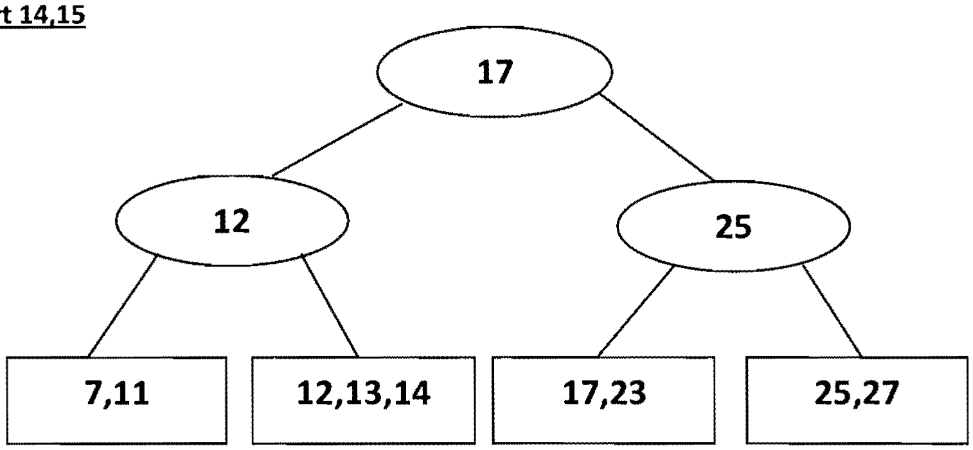


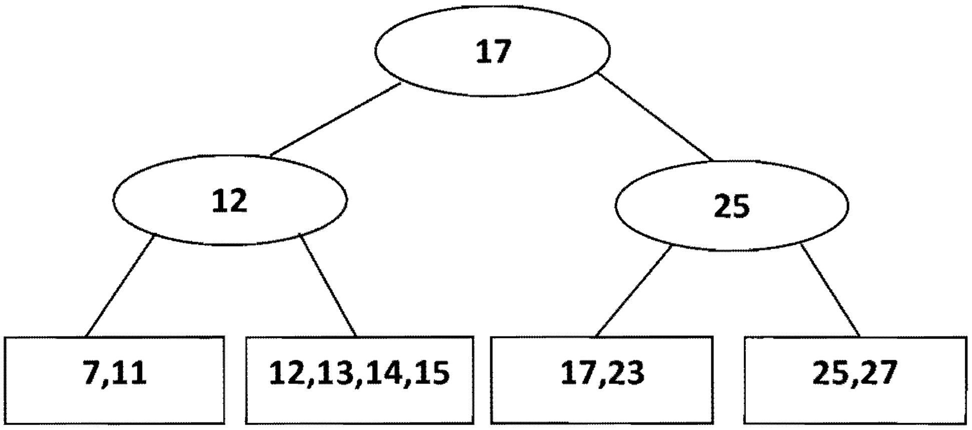
Insert 27

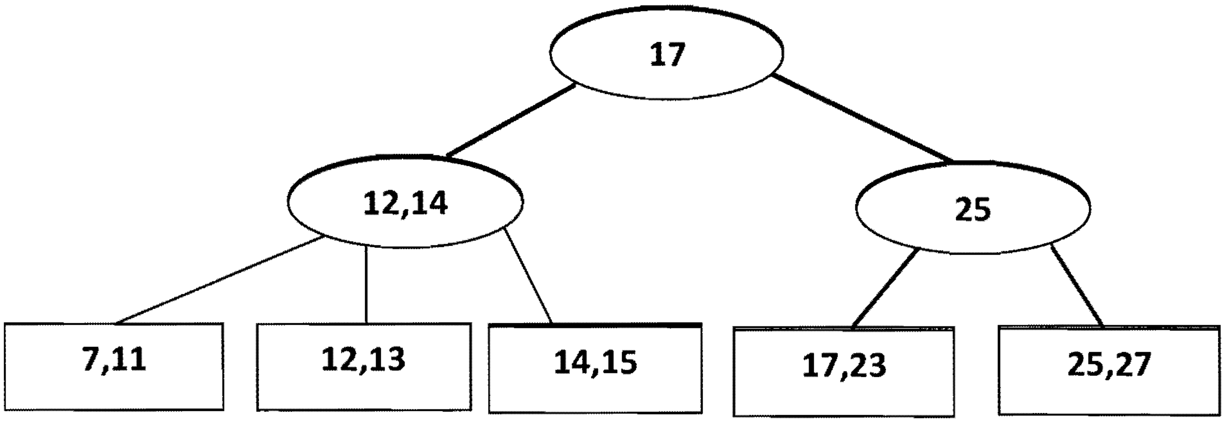


T8/1

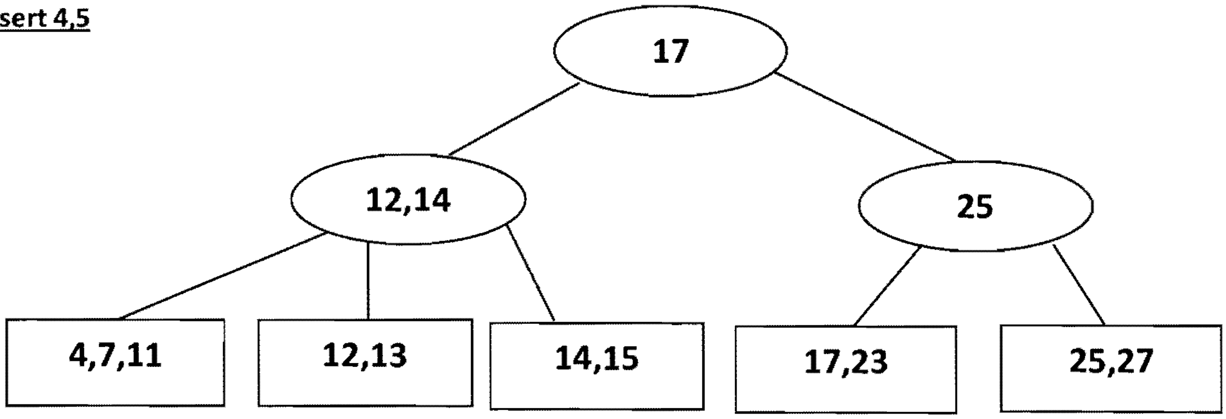
Insert 14,15



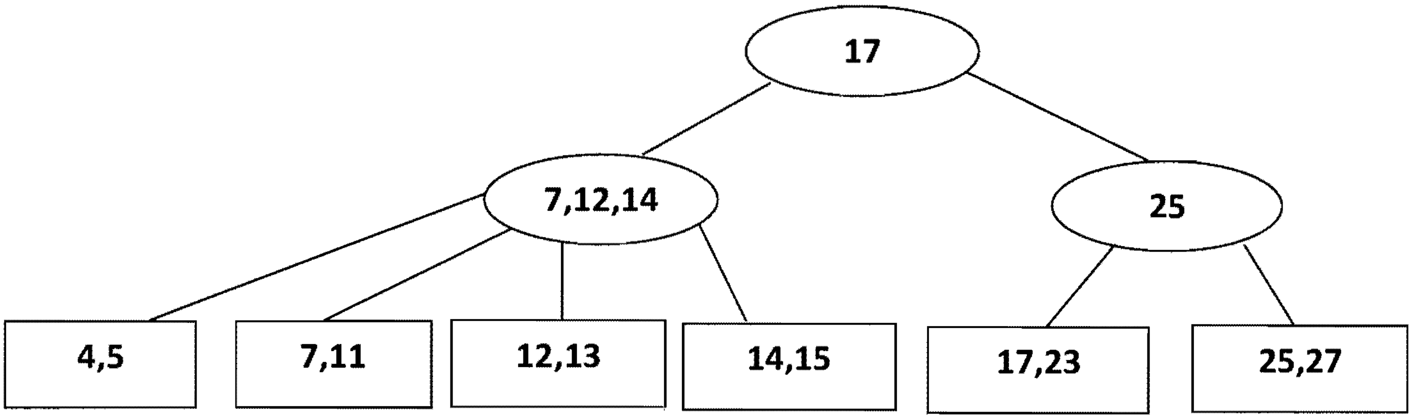


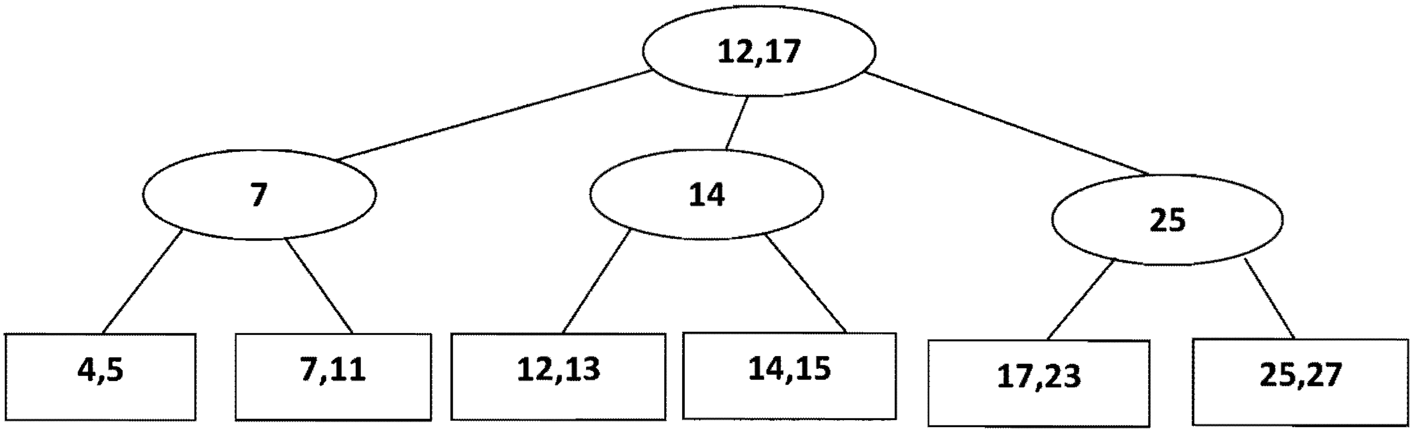


Insert 4,5

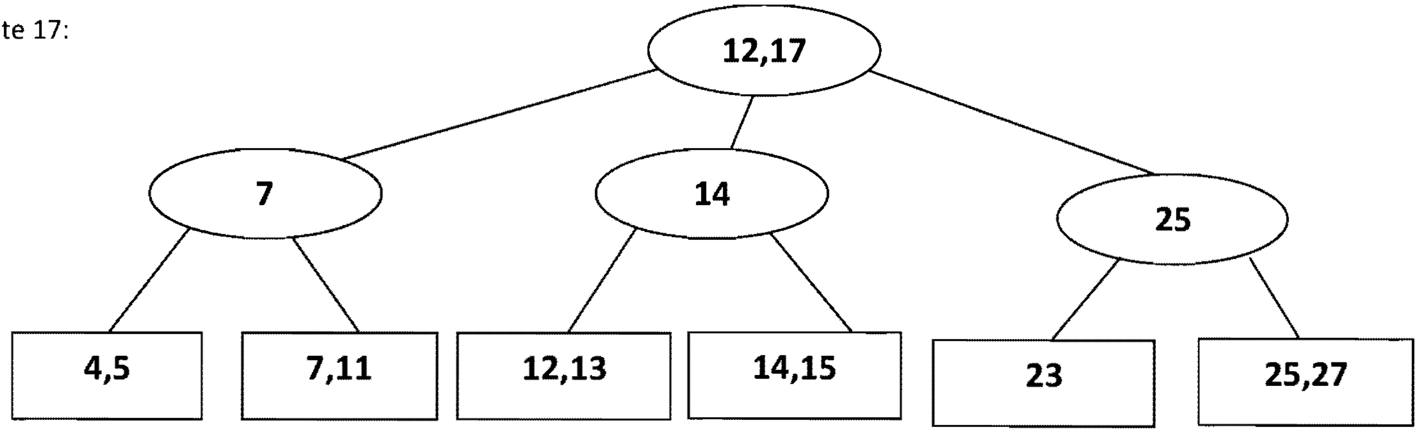


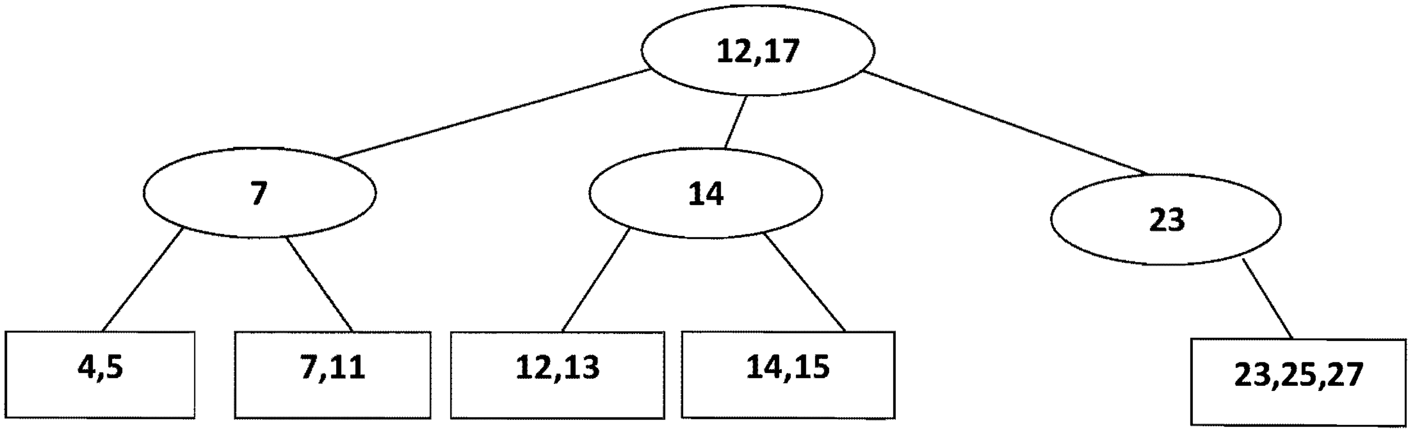
T8/2



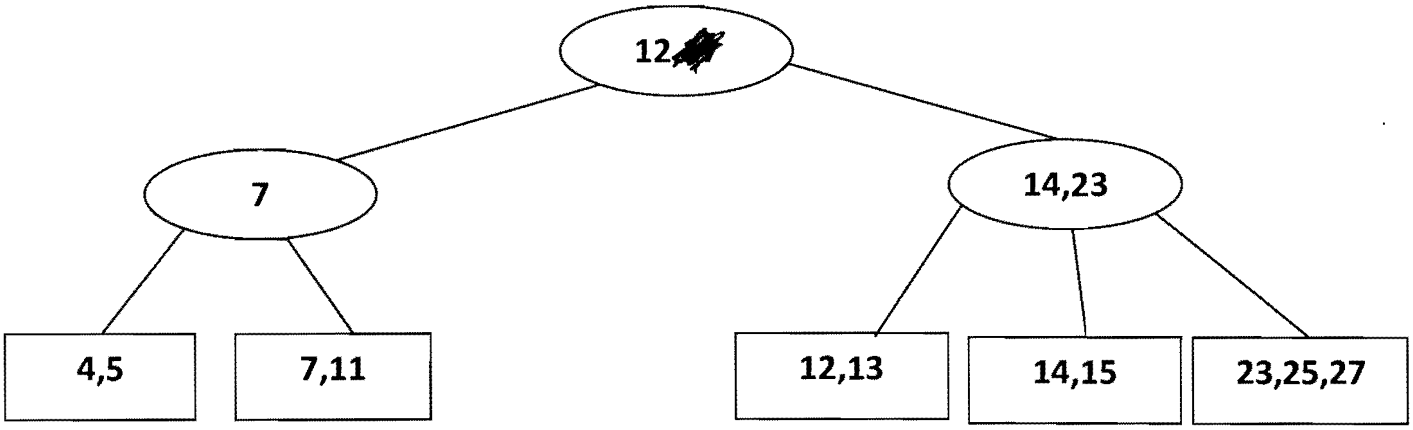


Delete 17:





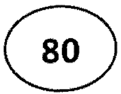
T 8/3



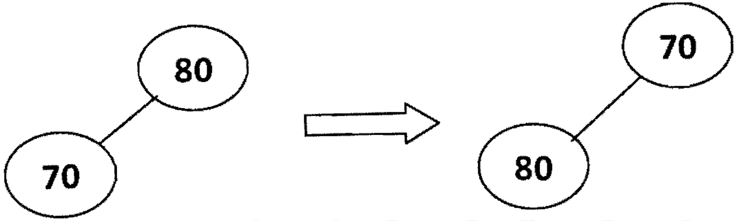
T8/4

Q2
a

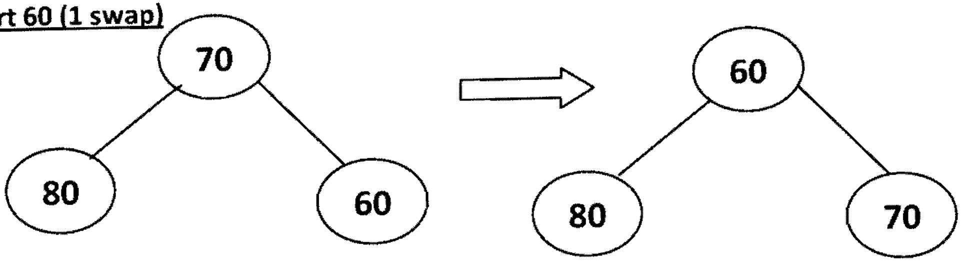
Insert 80 (0 swap)



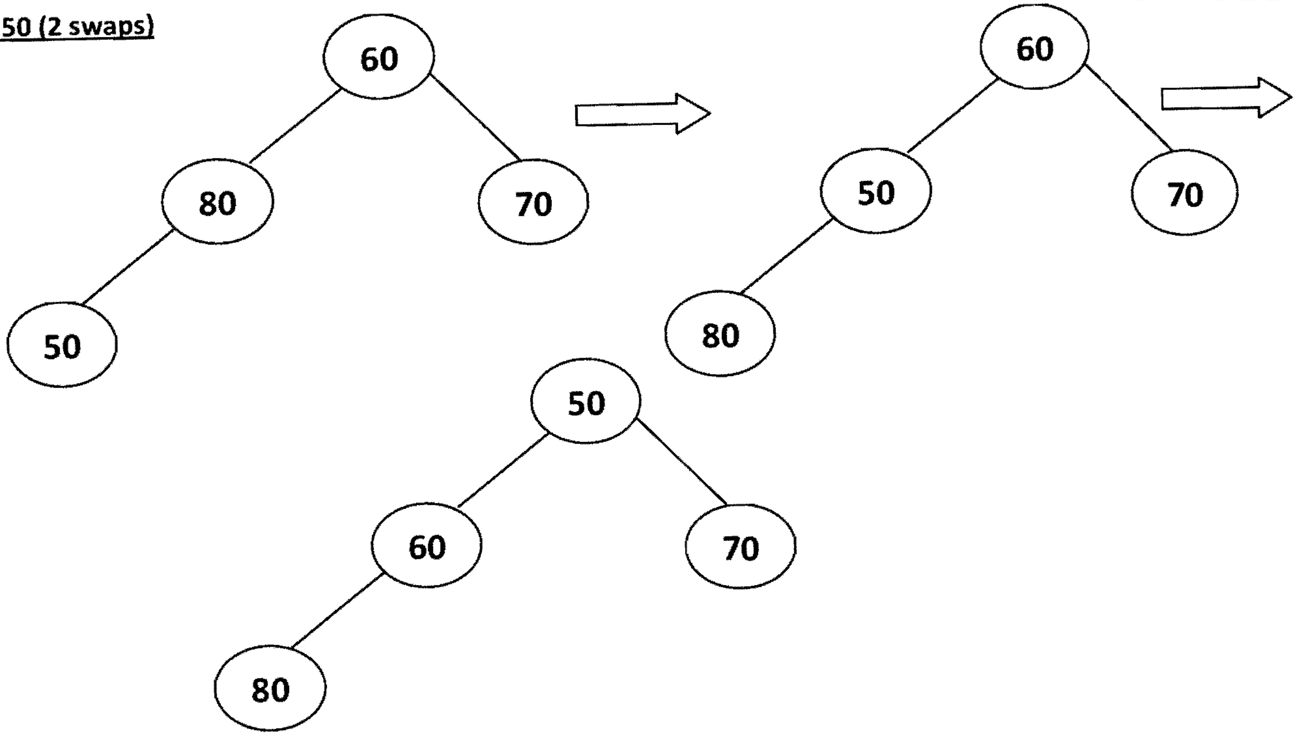
Insert 70 (1 swap)



Insert 60 (1 swap)

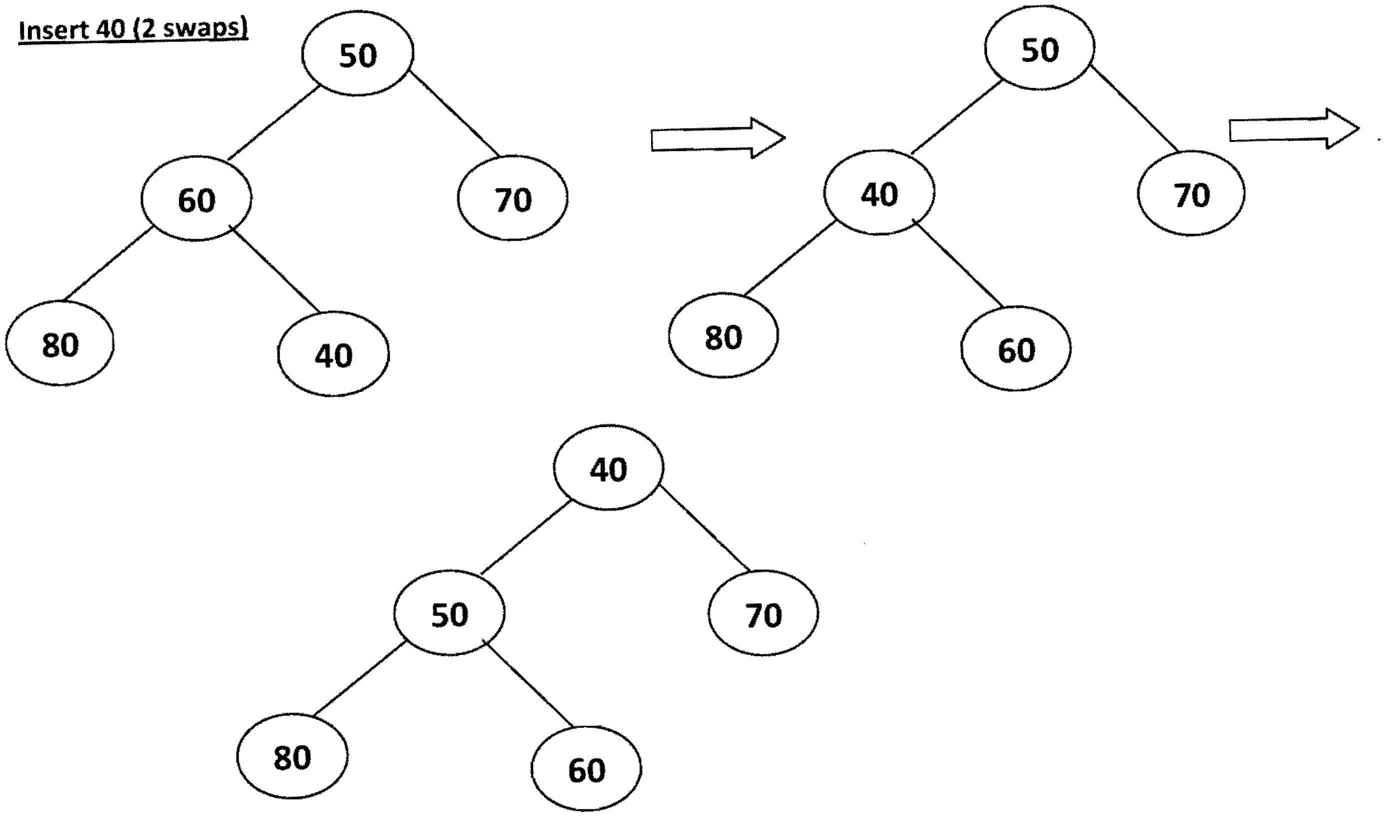


Insert 50 (2 swaps)

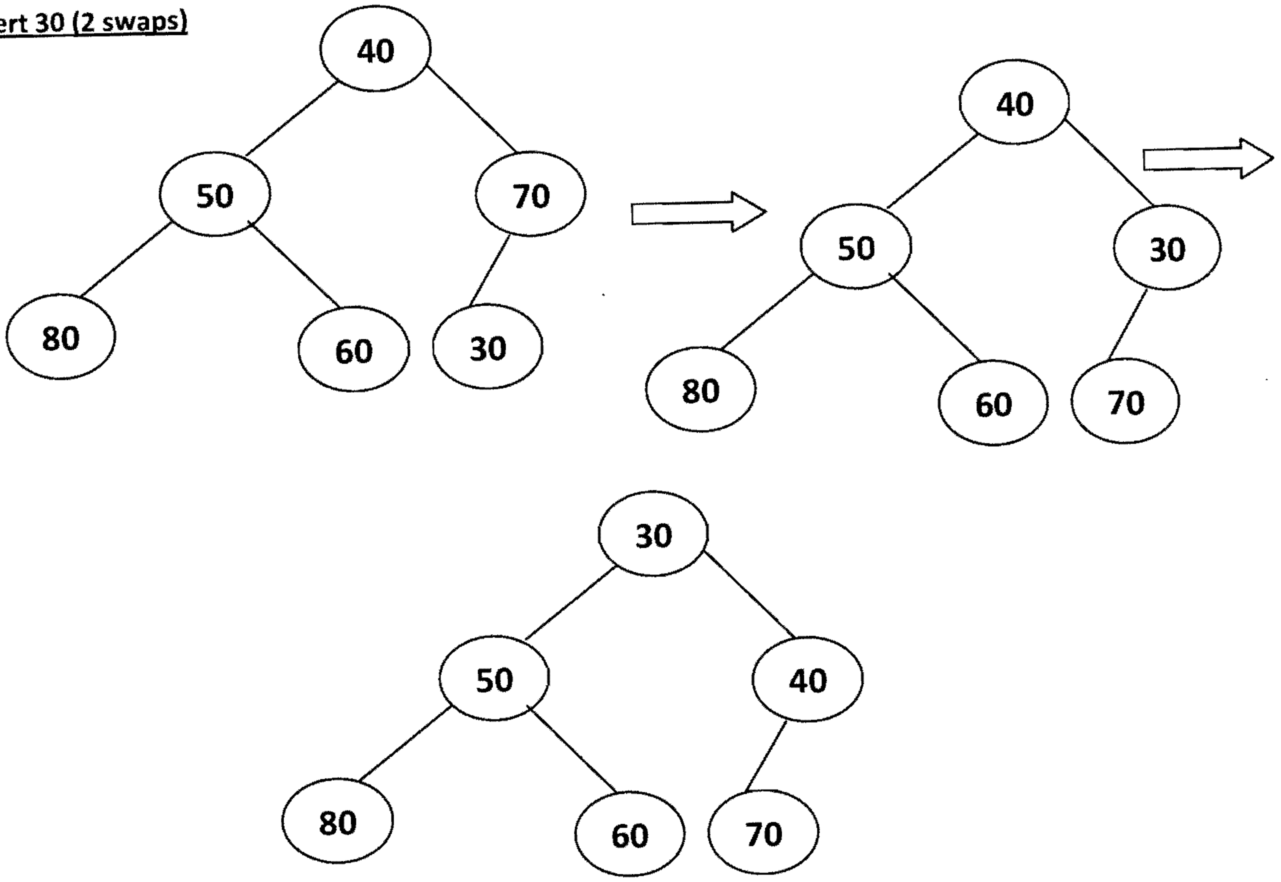


T8/5

Insert 40 (2 swaps)

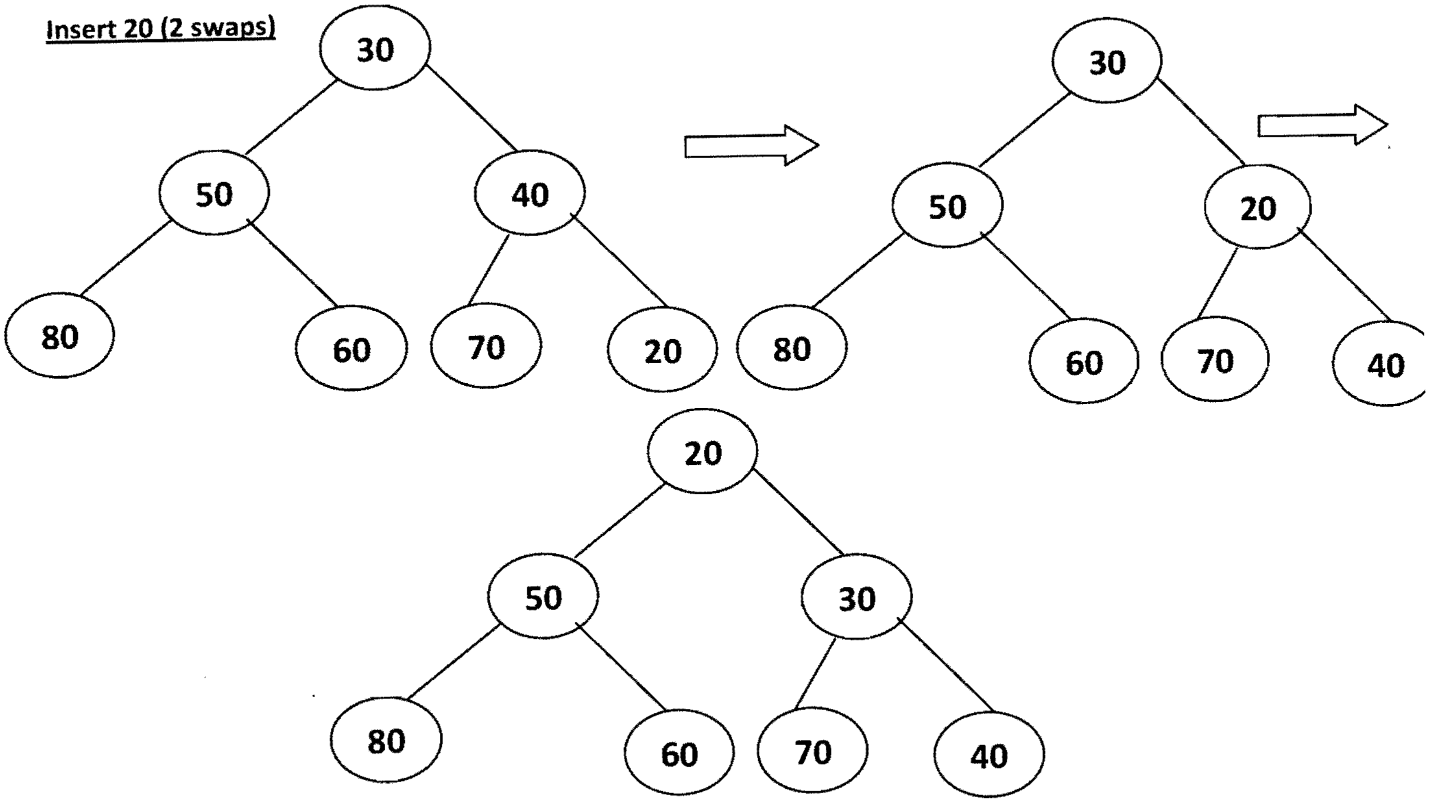


Insert 30 (2 swaps)

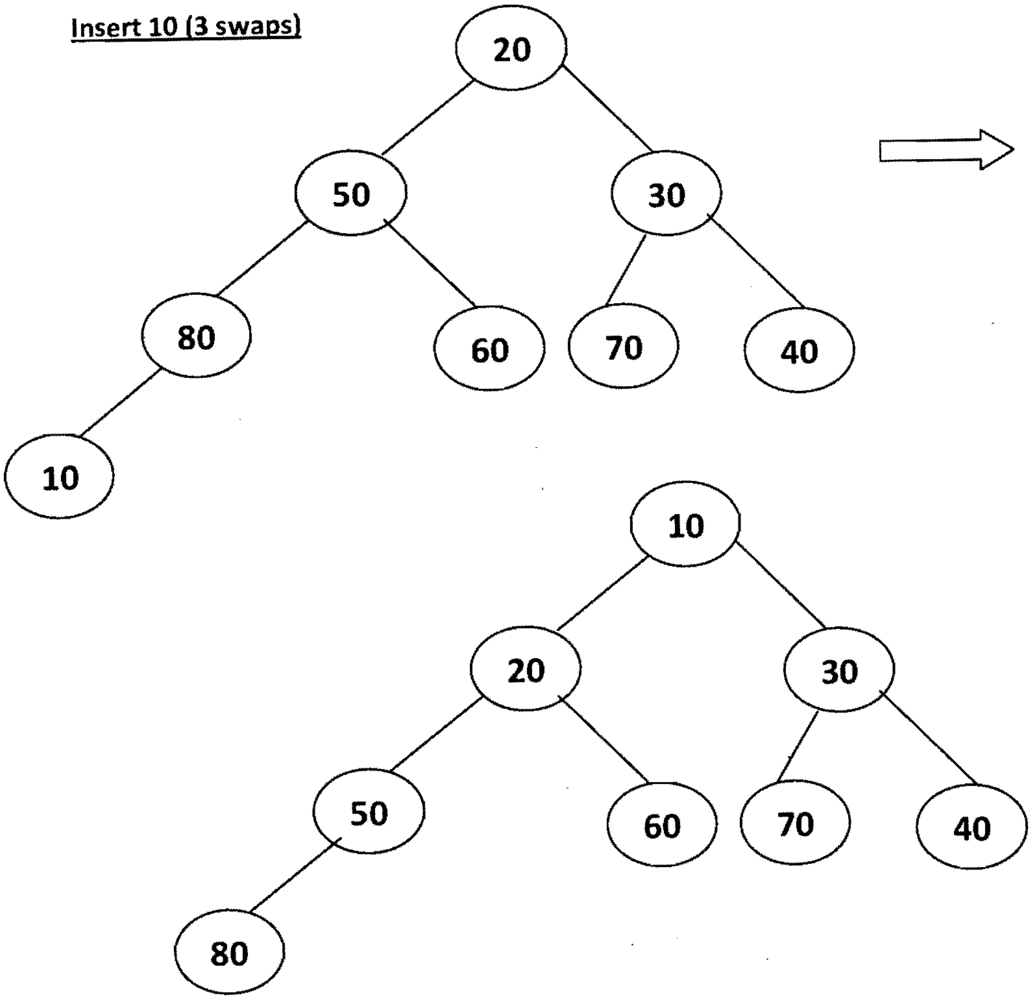


T8/6

Insert 20 (2 swaps)

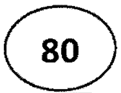


Insert 10 (3 swaps)

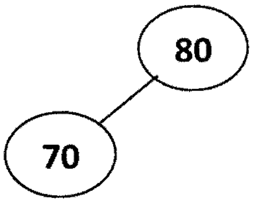


TS/7

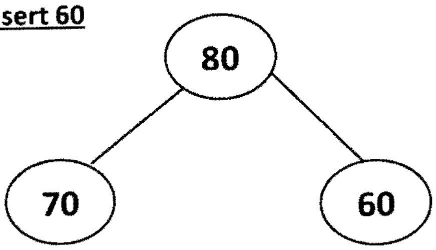
Insert 80



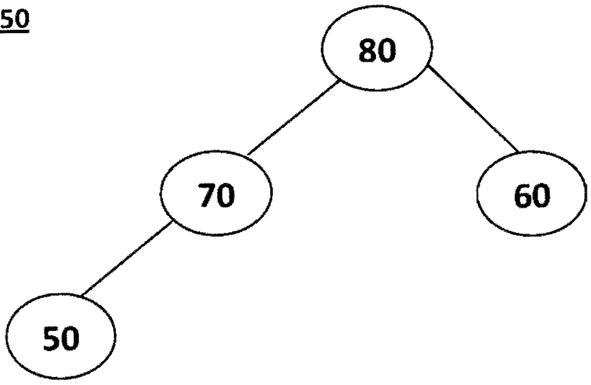
Insert 70



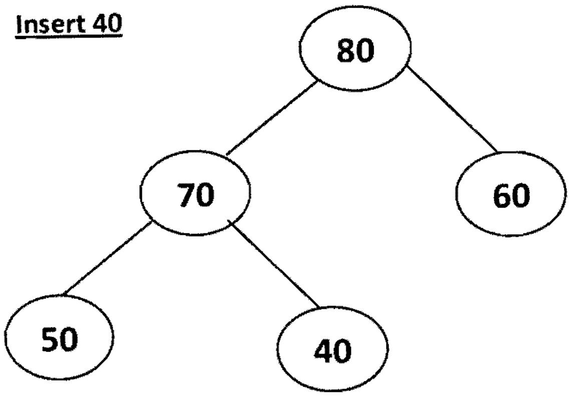
Insert 60



Insert 50

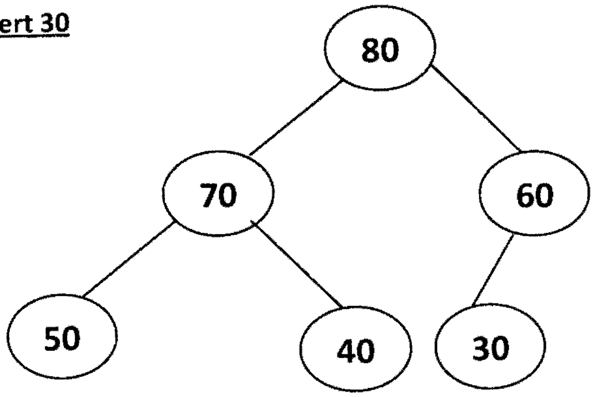


Insert 40

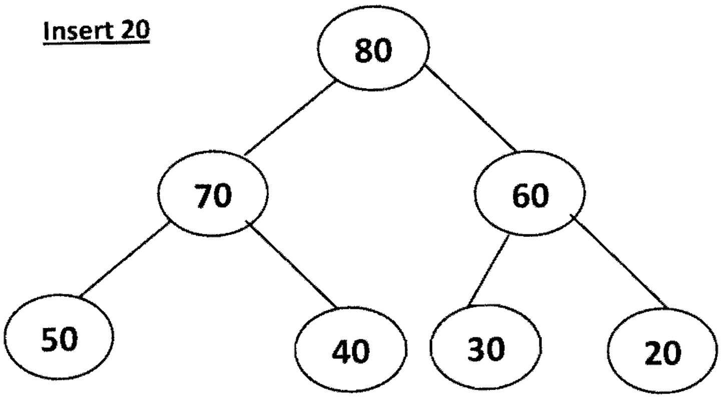


T8/8

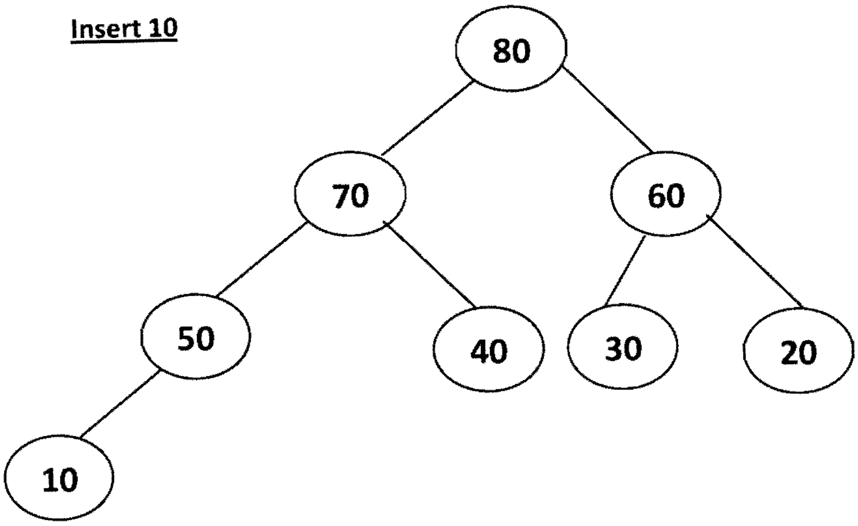
Insert 30



Insert 20



Insert 10



T8/9

Q2
b

(i) in sorted order : no of swaps 0.

(ii) already heap : 0.

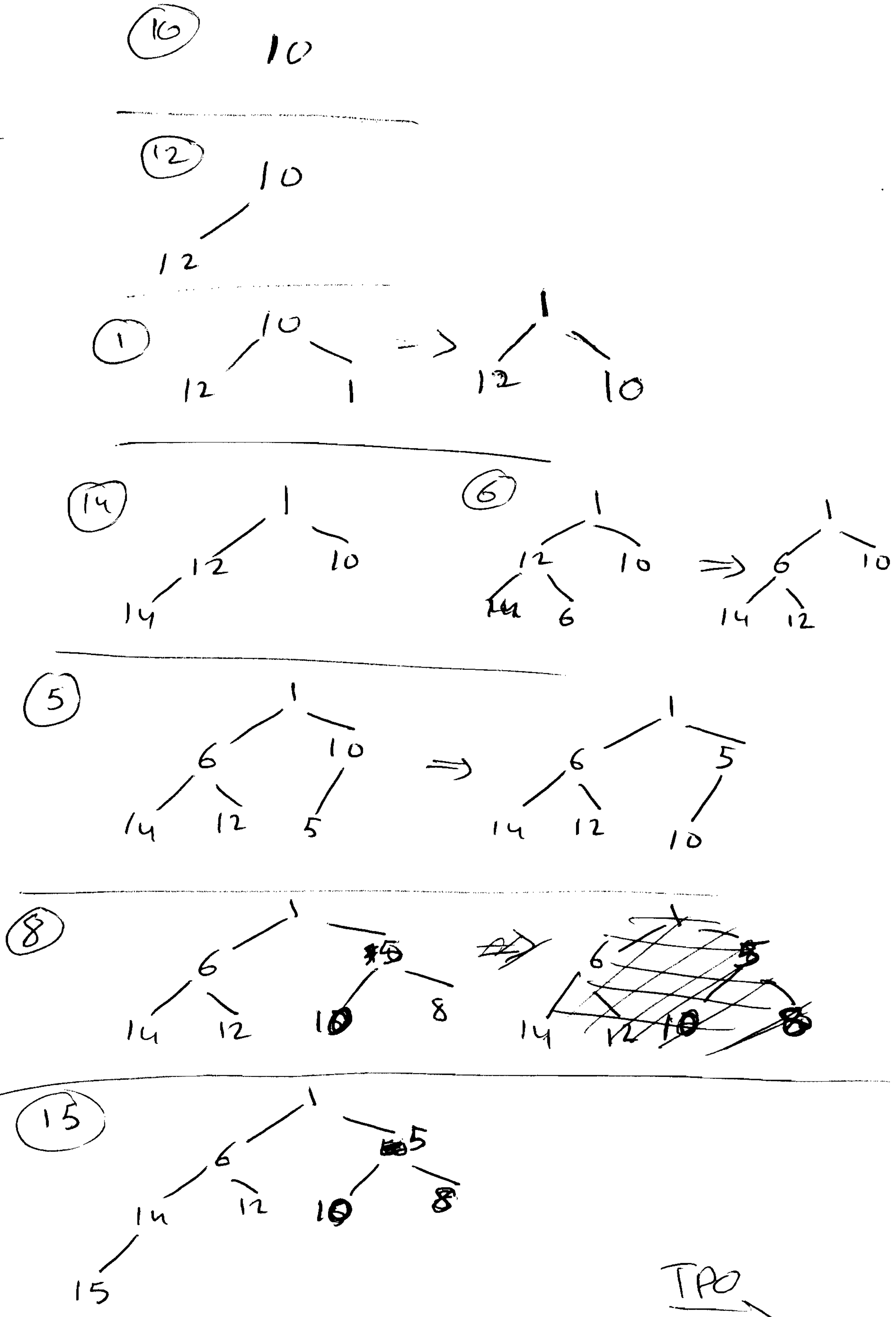
(iii) inverse sorted order :

$$\sum_{i=1}^{h} 2^i * i$$

T8/10

Q3

a

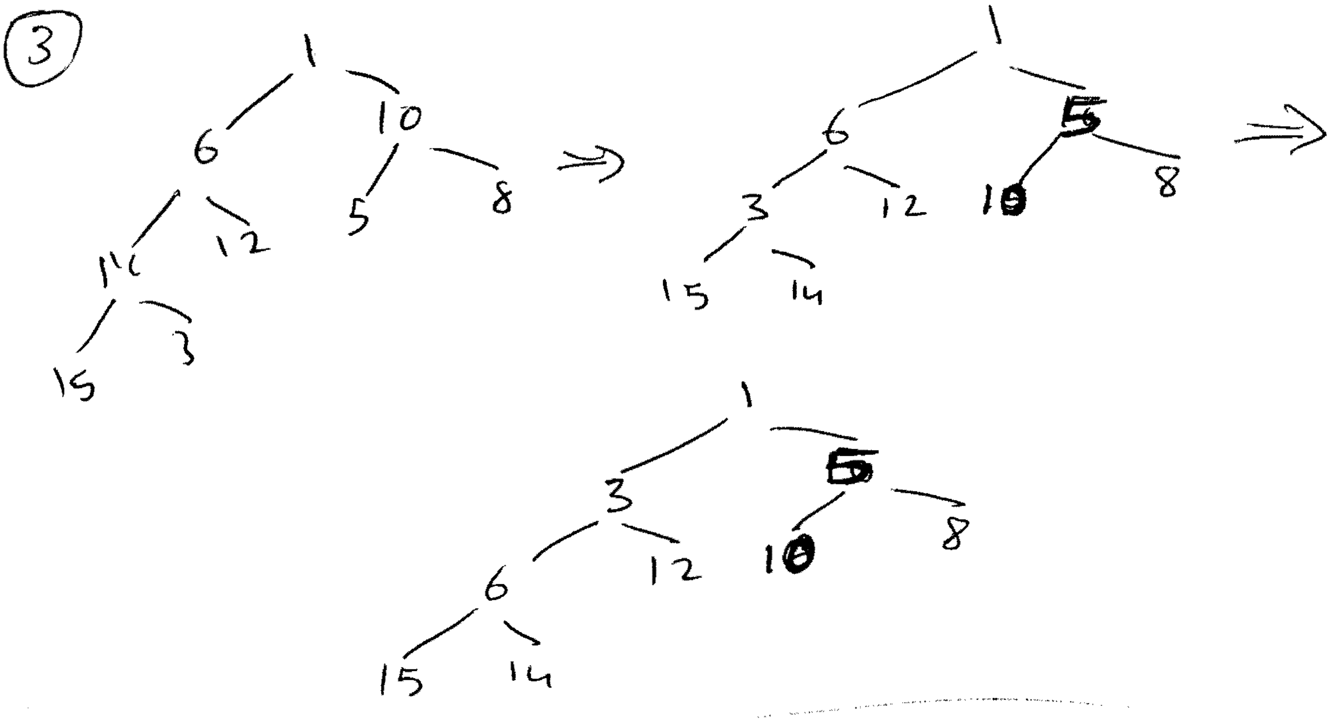


TPO →

T 8/11

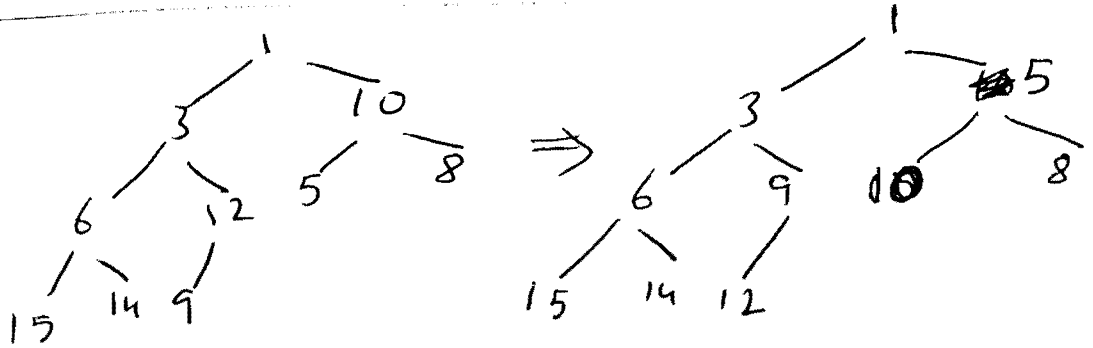
1

③



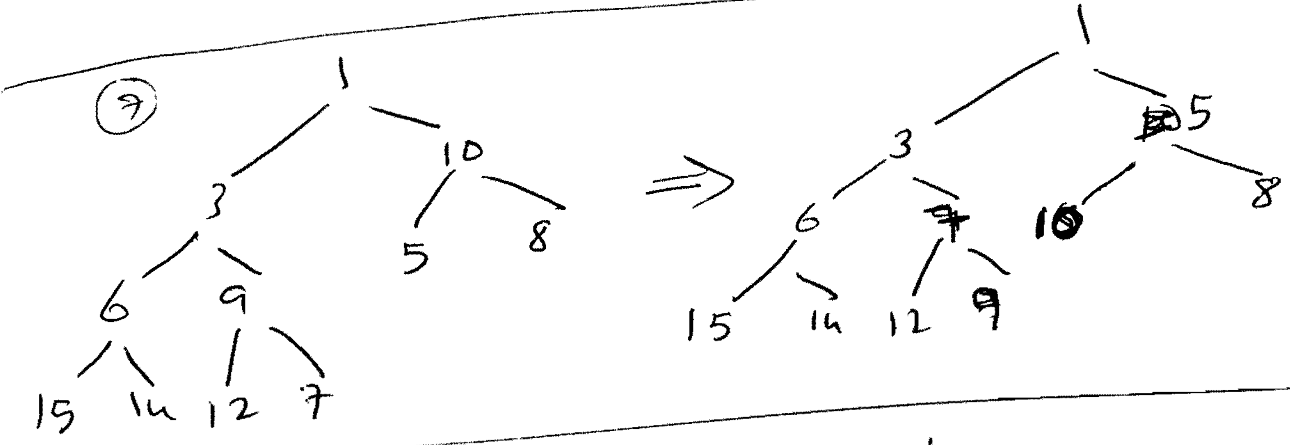
1
6 10
14 12 5 8
15 3
1
6 5
3 12 10 8
15 14
1
3 5
6 12 10 8
15 14

⑨



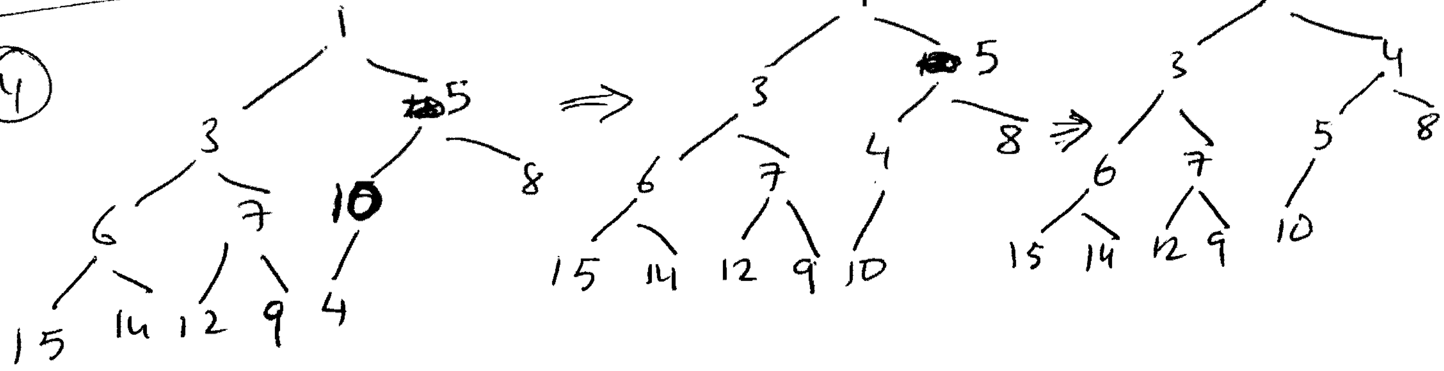
1
3 10
6 12 5 8
15 14 9
1
3 5
6 9 10 8
15 14 12

⑦



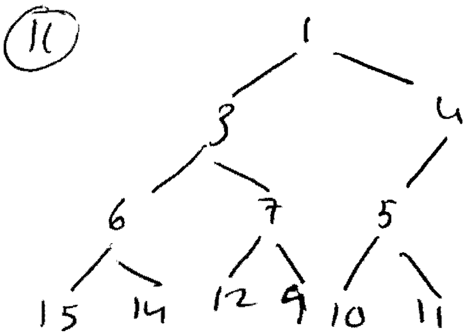
1
3 10
6 9 5 8
15 14 12 7
1
3 5
6 7 10 8
15 14 12 9

④



1
3 5
6 7 10 8
15 14 12 9 4
1
3 5
6 7 4 8
15 14 12 9 10
1
3 4
6 7 5 8
15 14 12 9 10

11



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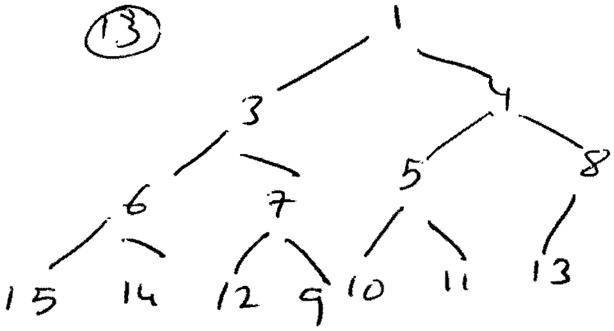

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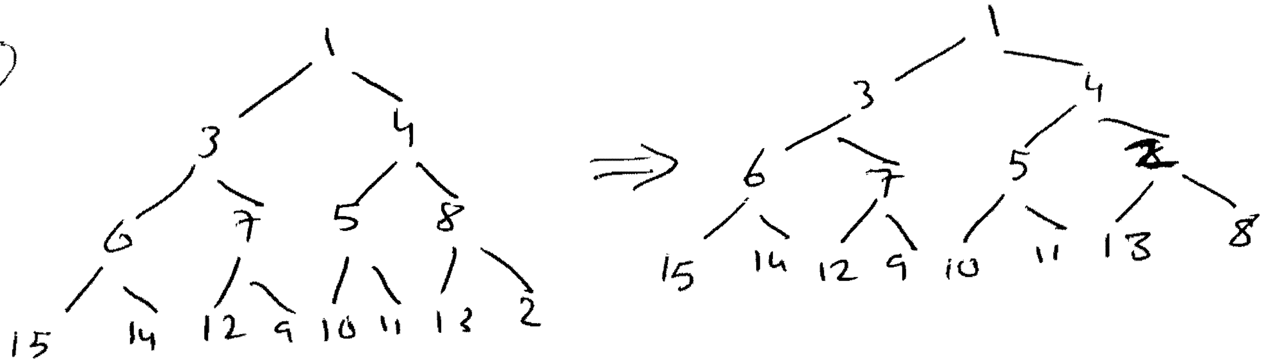
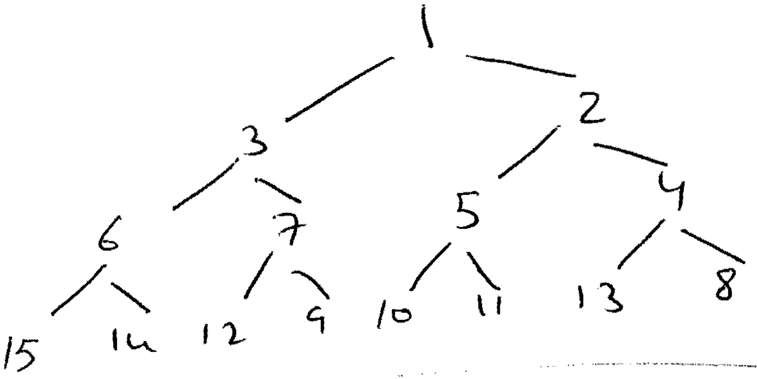
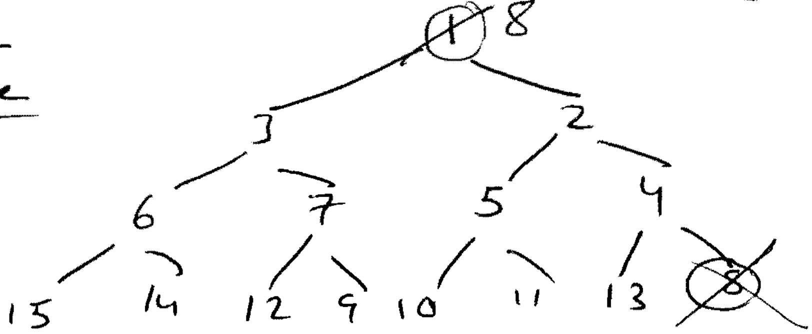
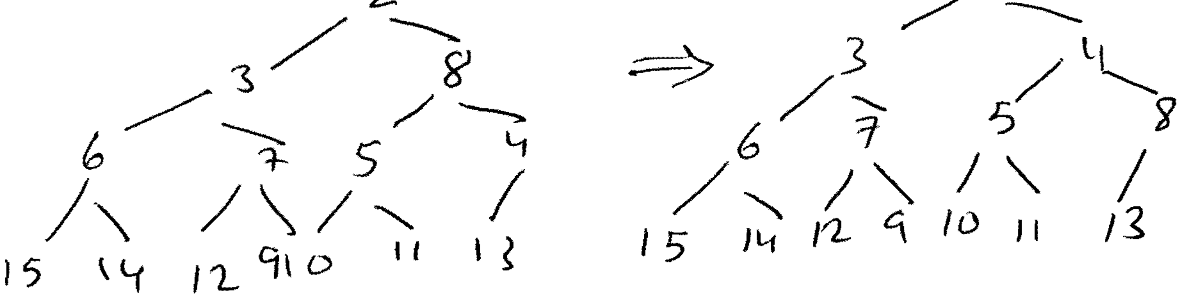




Q3 b) dequeue ~~first~~ first time

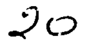




T8/12

Q3/c

20



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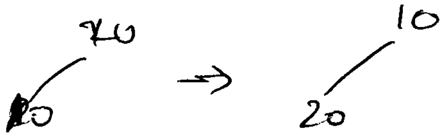

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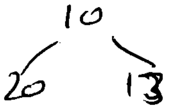

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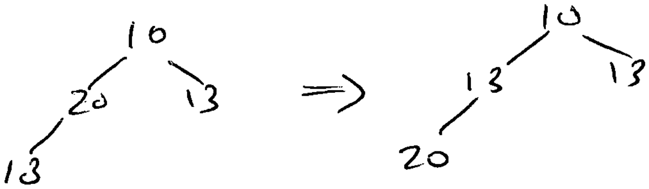

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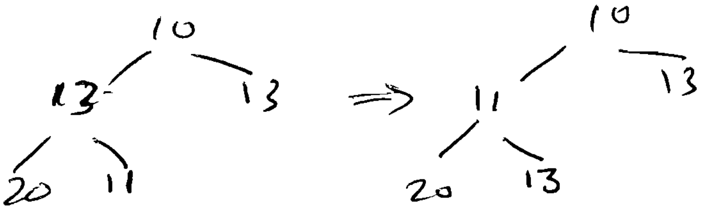

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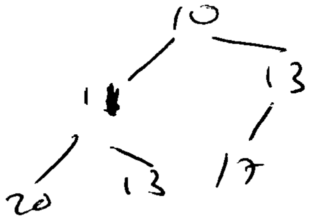

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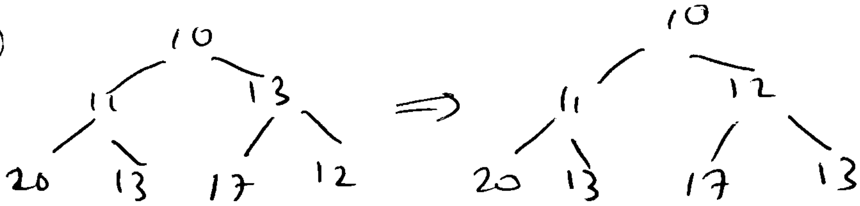

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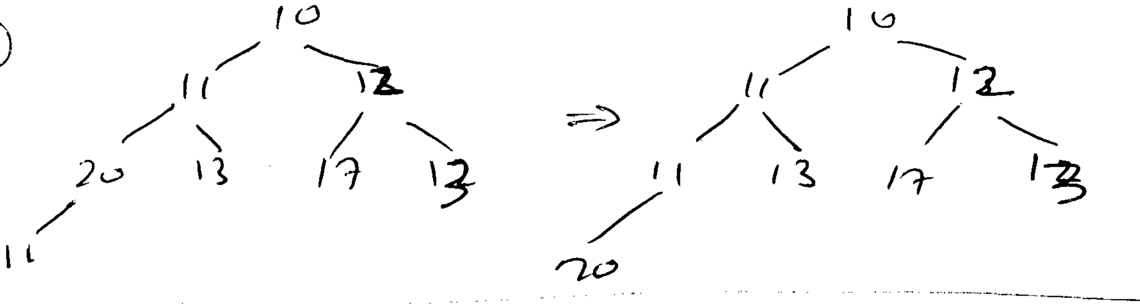

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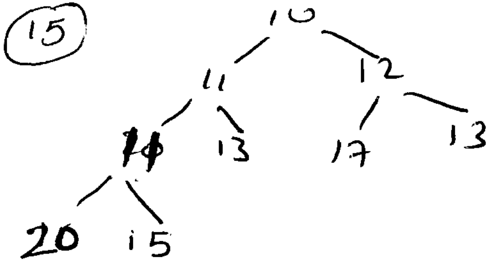

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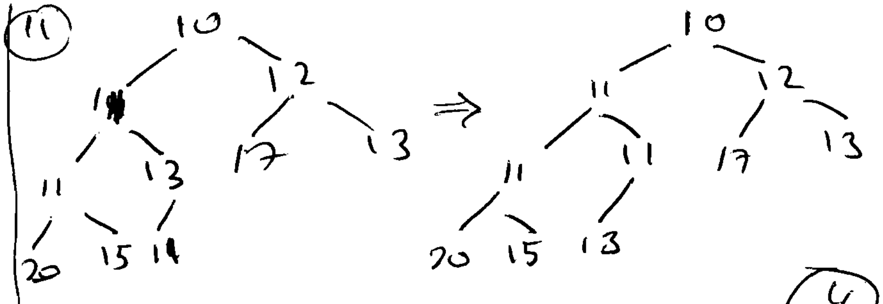


Q4 in the Notes

Q5 (a) Can a BST satisfy heap condition.

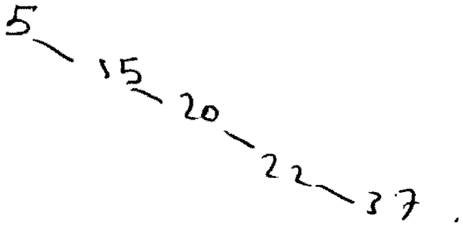
NO.

because in BST Right ≥ parent and
Left < parent

~~(b)~~

(b) No. Same as BST.

(c) Yes if the keys were sorted.
like 5 15 20 22 37



T8/13