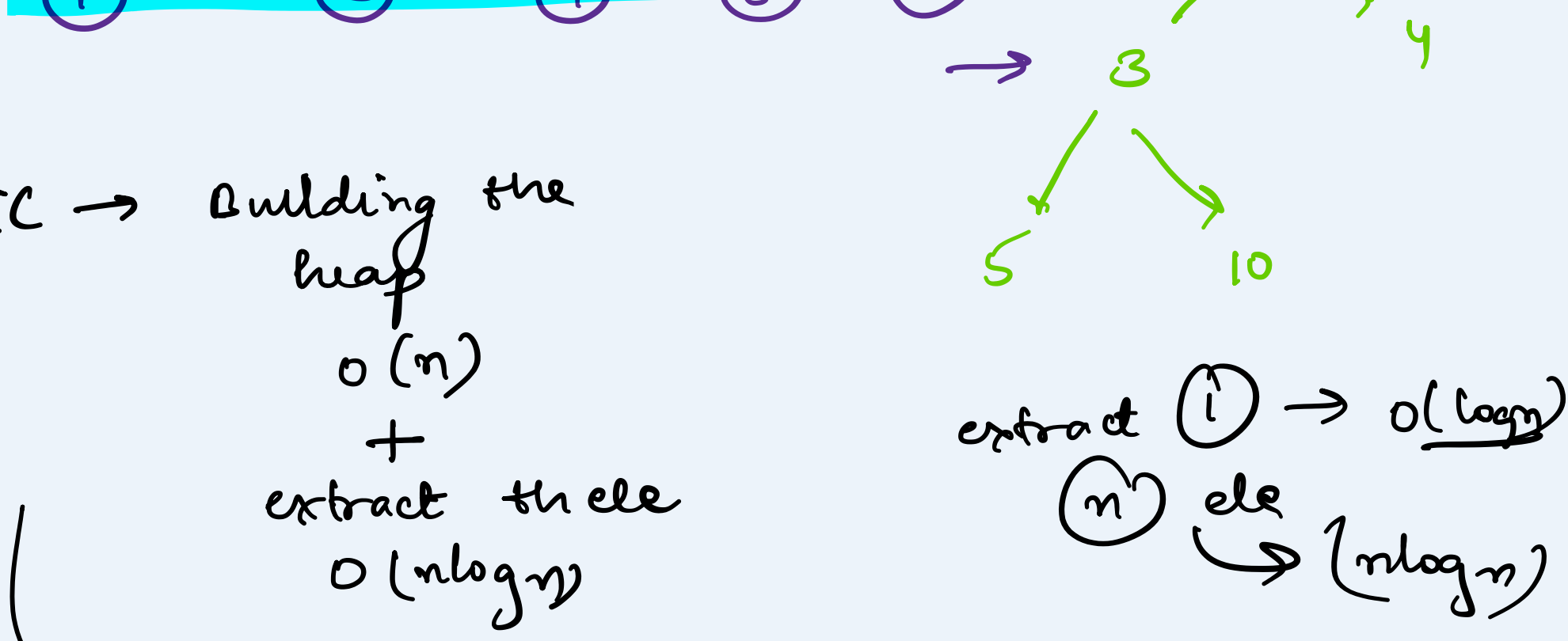


Q

Heap Sort

Eg: $[1, 5, 3, 4, 10]$
 sort $\rightarrow [1, 3, 4, 5, 10]$

Approach: Put all elements in a min-heap.
 Extract the min ele one by one.



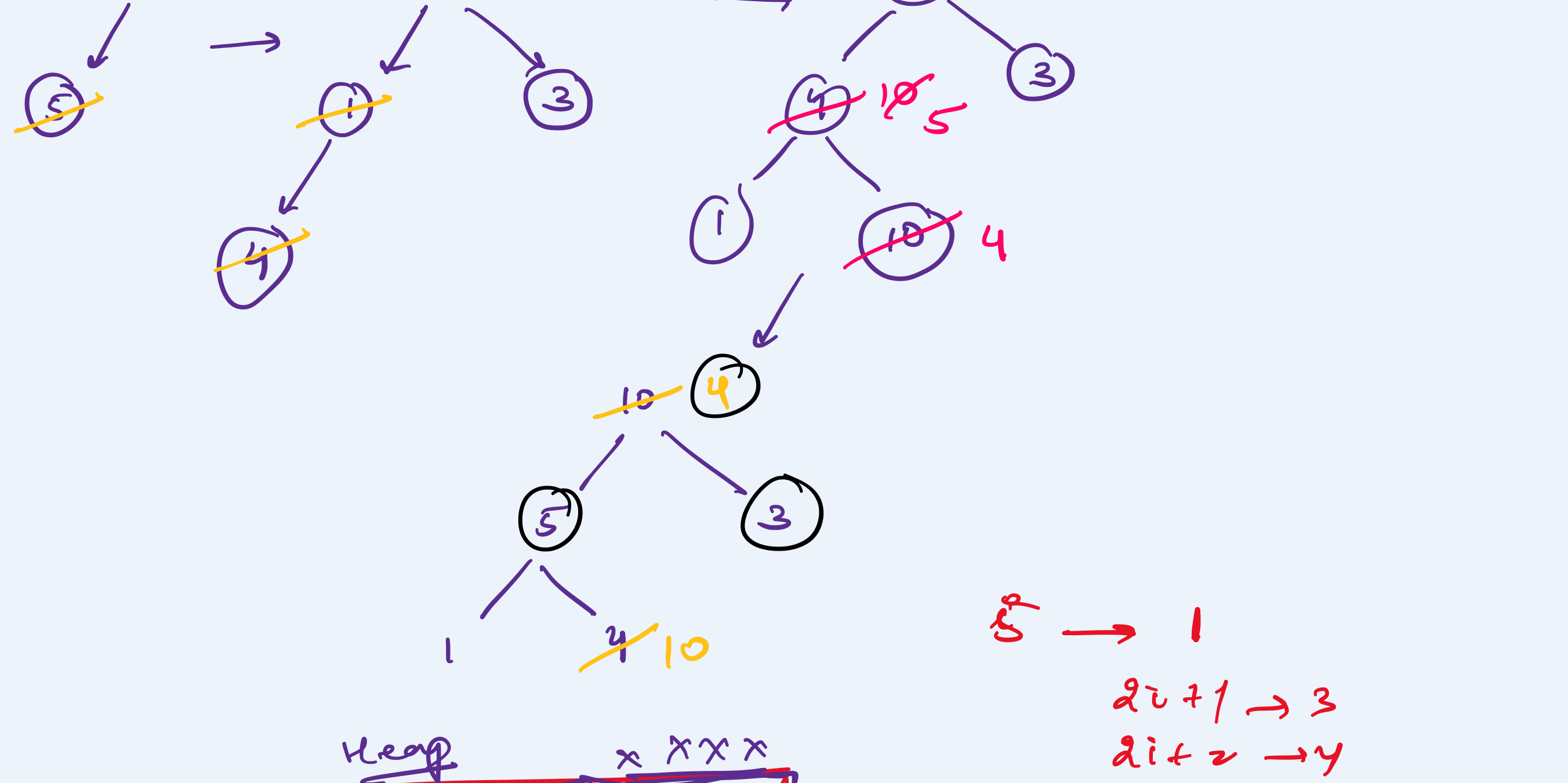
TC \rightarrow Building the heap $O(n)$
 + extract the ele $O(n \log n)$
 $O(n \log n)$

extract (1) $\rightarrow O(\log n)$
 (n) ele $\rightarrow O(n \log n)$

SC $\rightarrow O(n)$

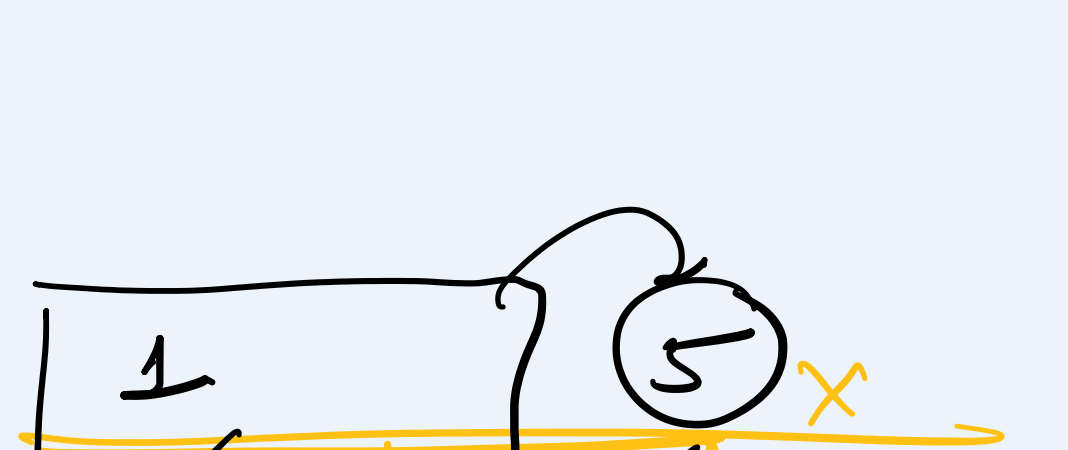
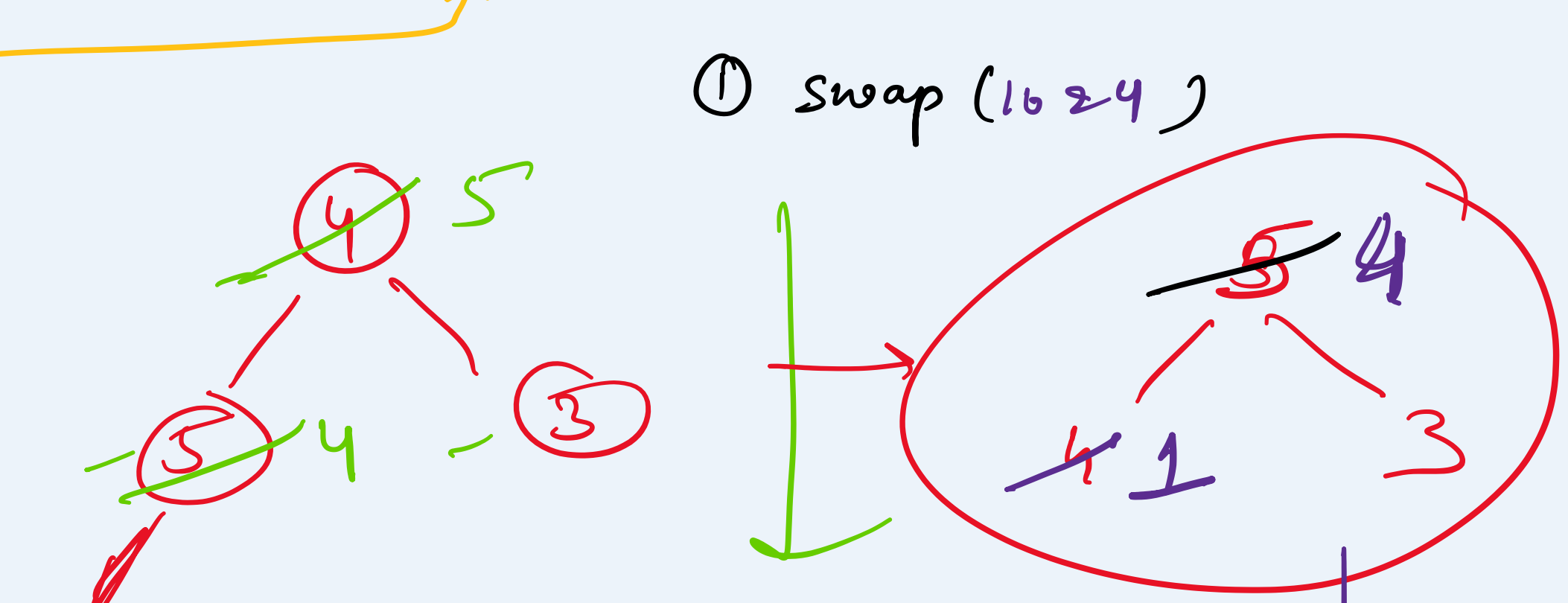
Approach (2): Max Heap

Ele $\rightarrow 1, 5, 3, 4, 10$

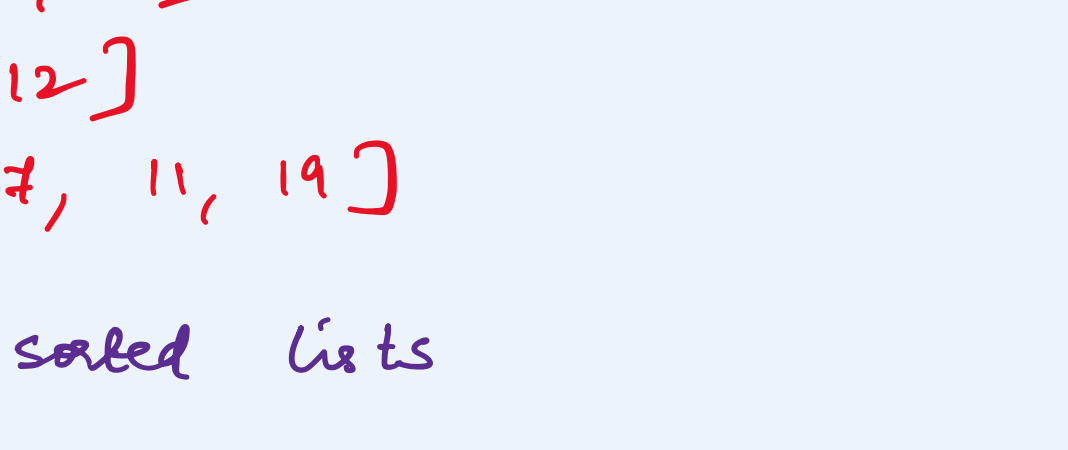
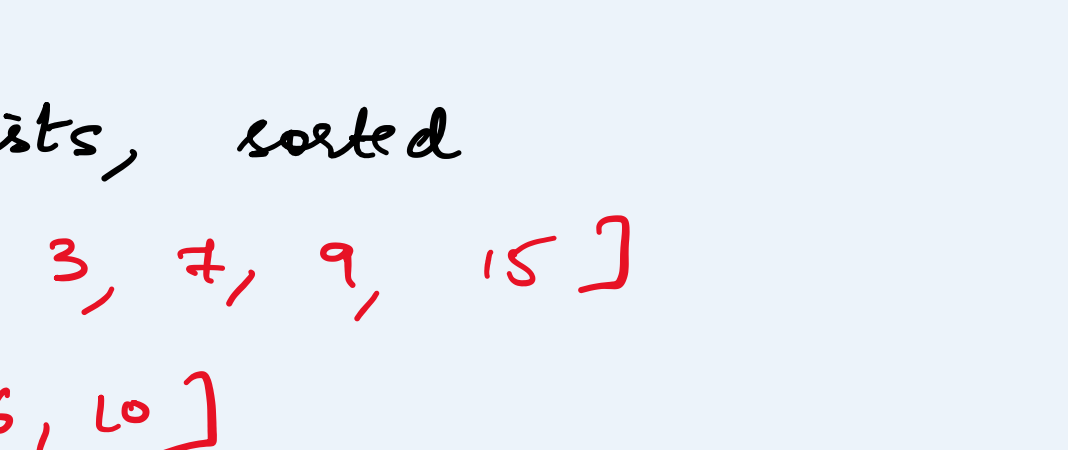
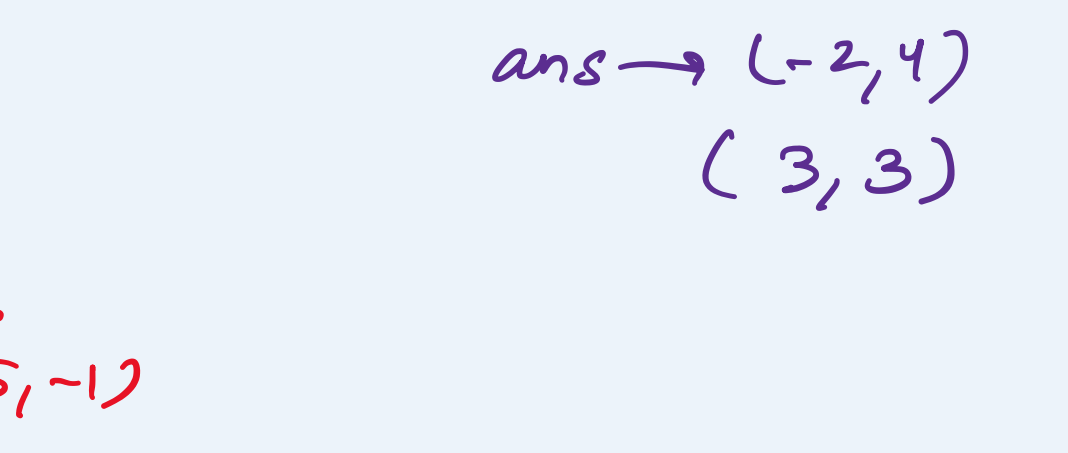
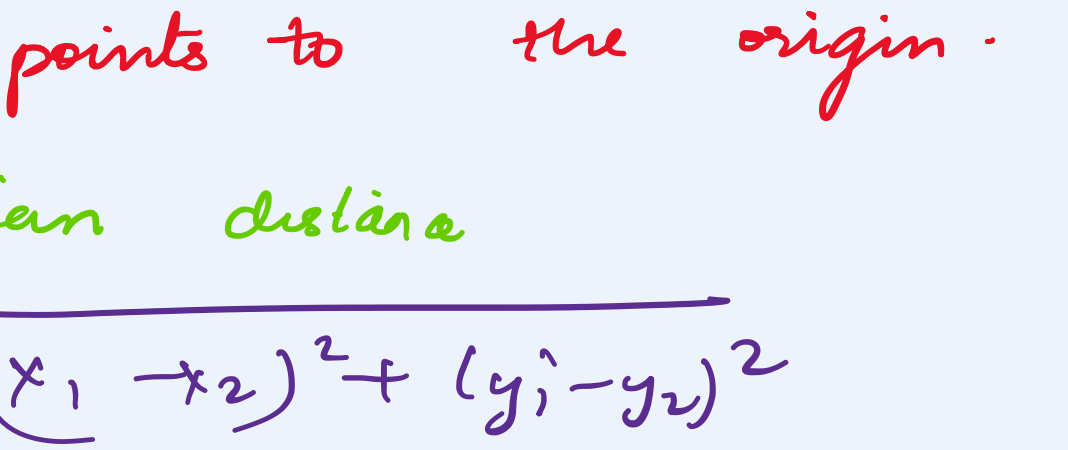
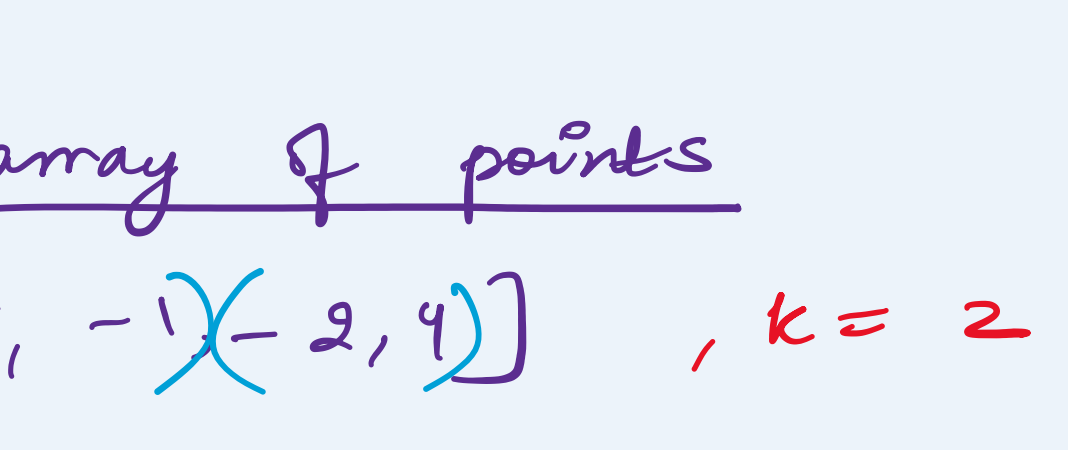
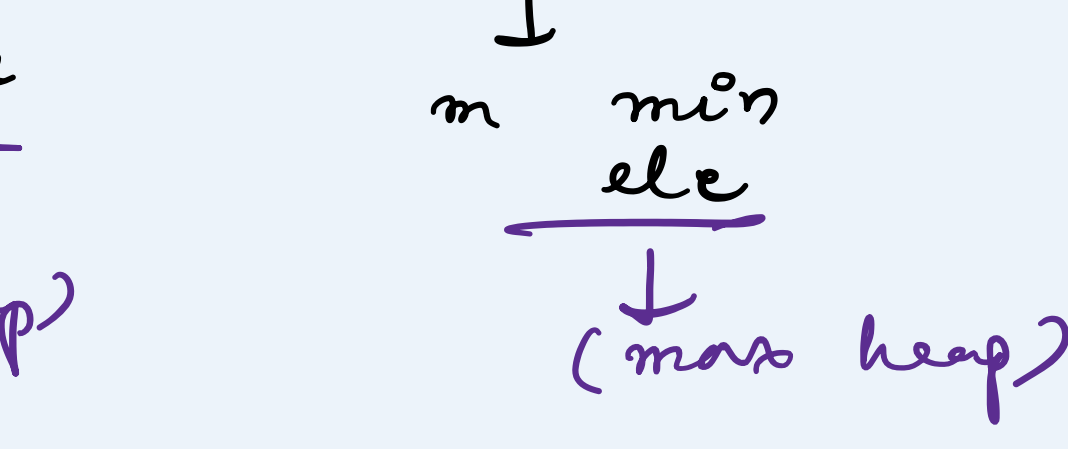
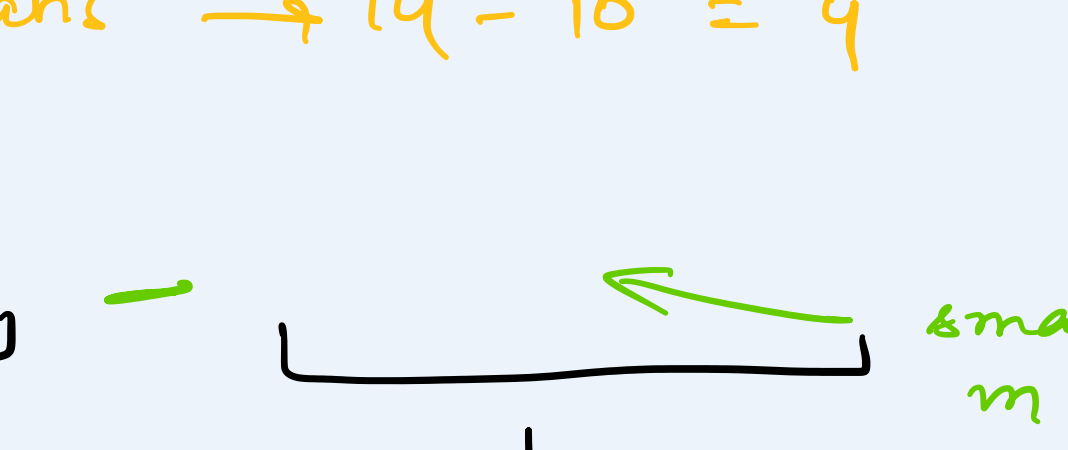
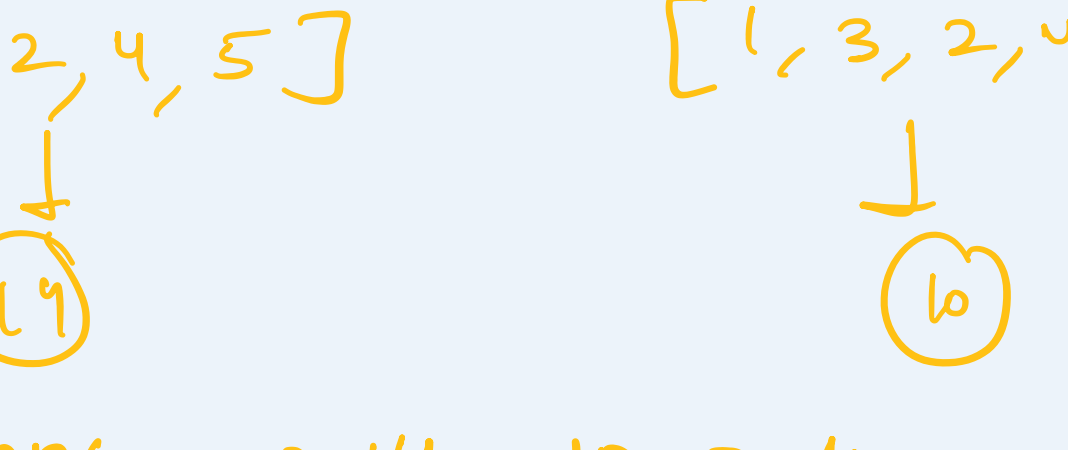
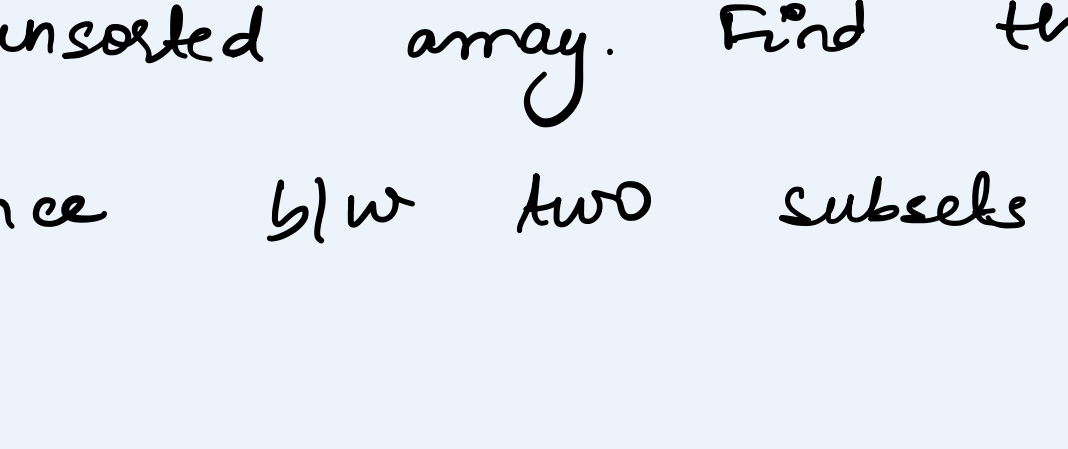
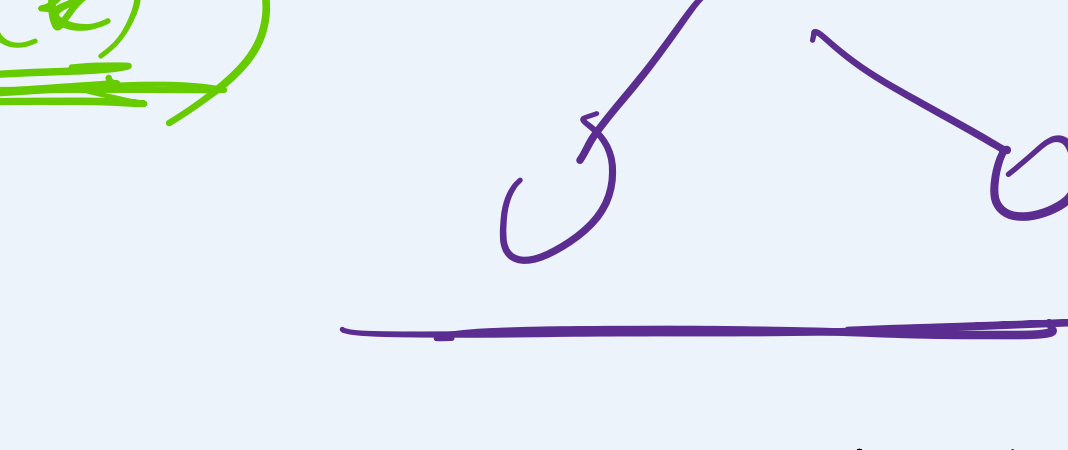
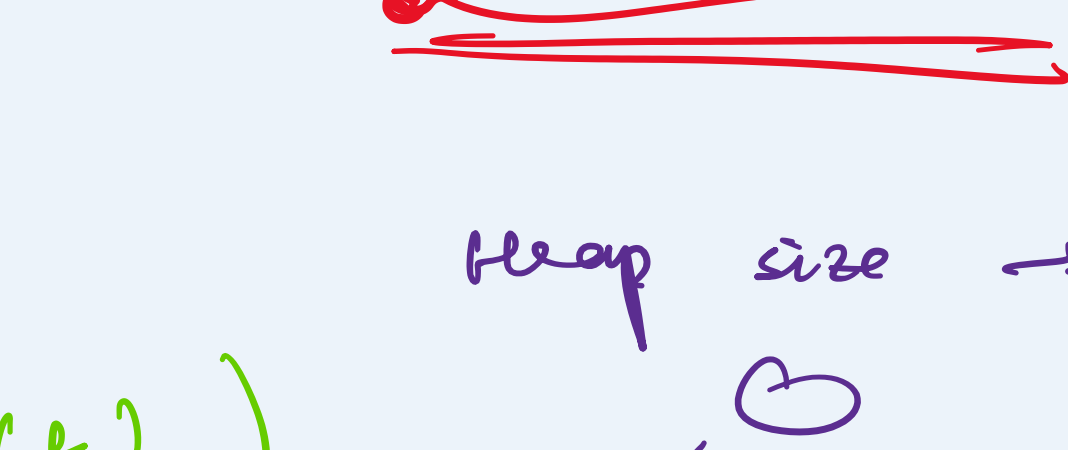
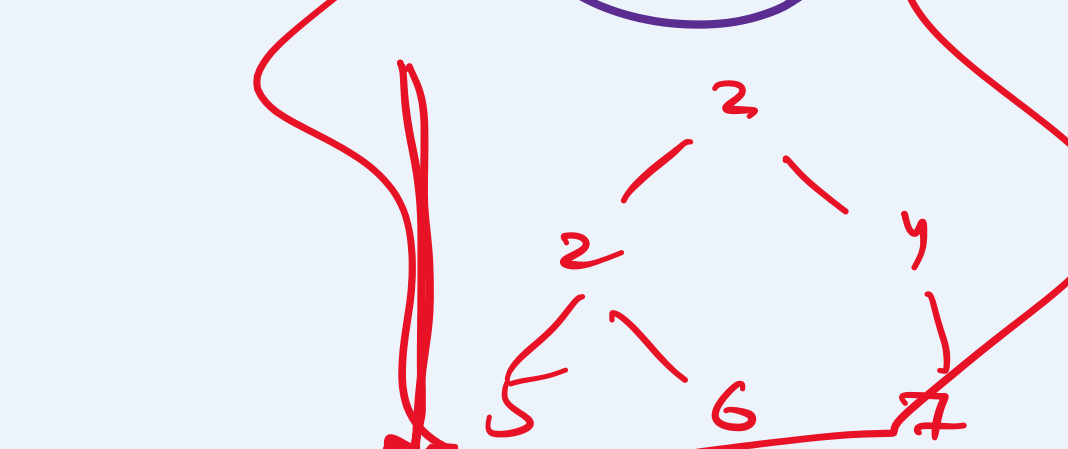
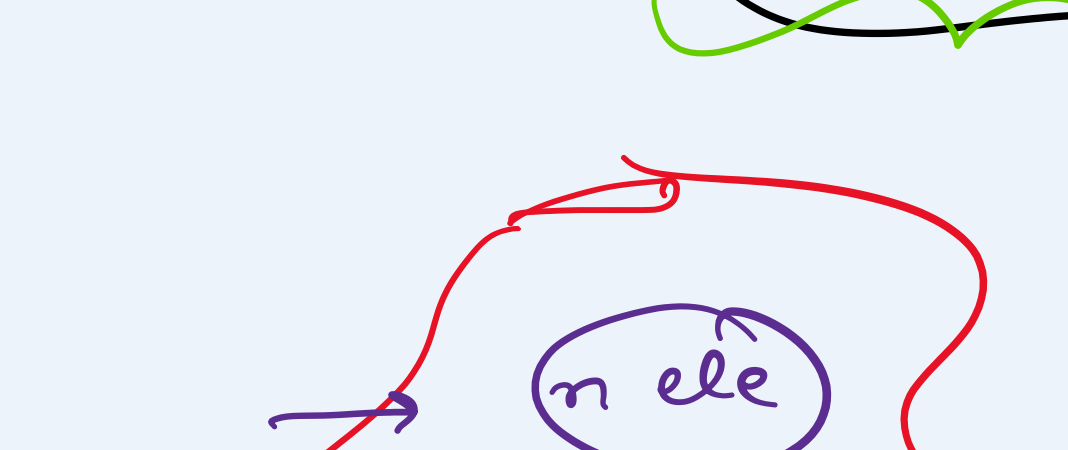
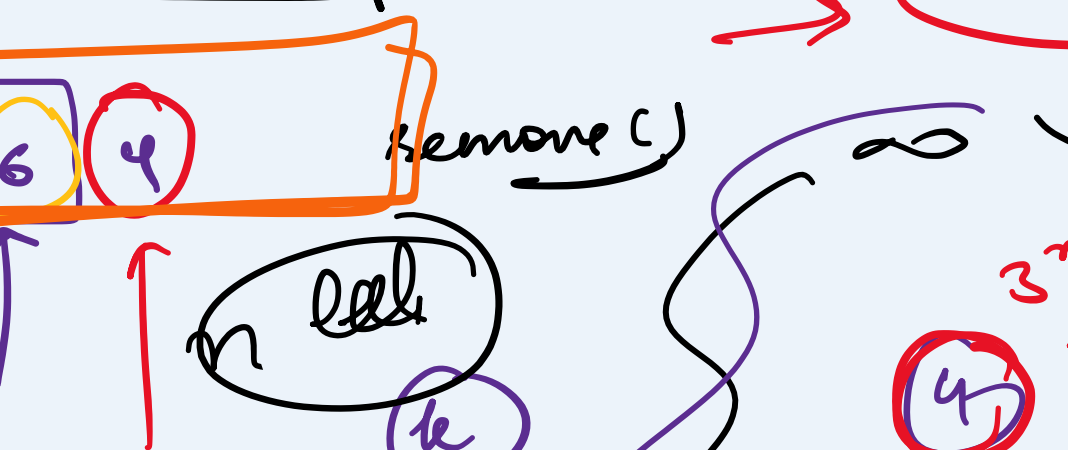
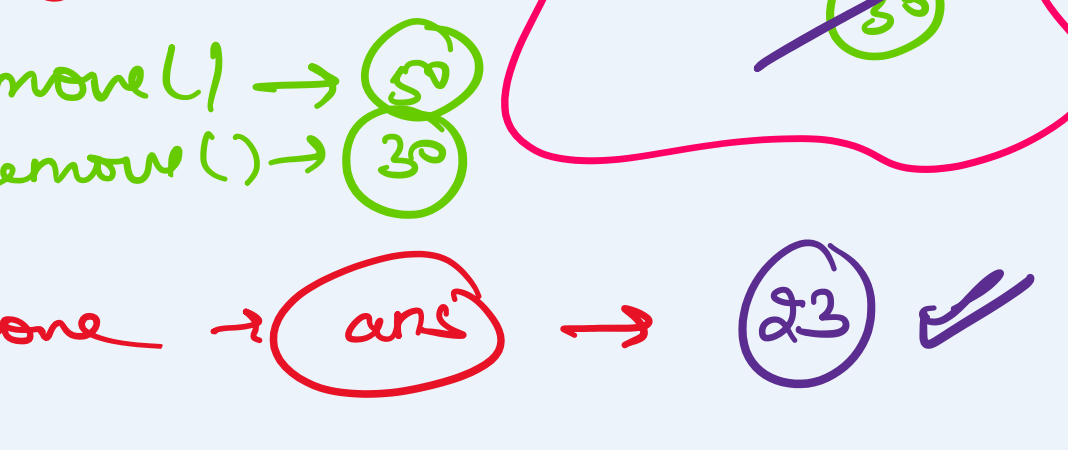
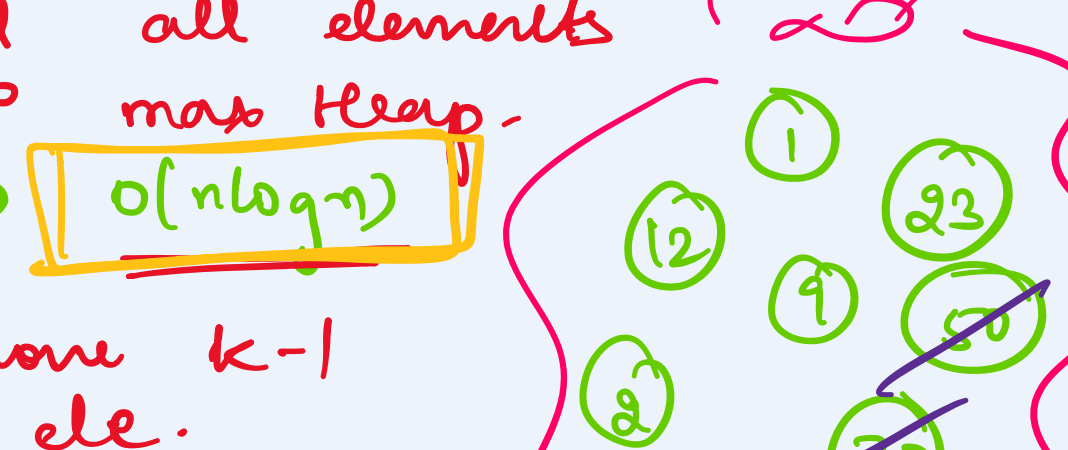
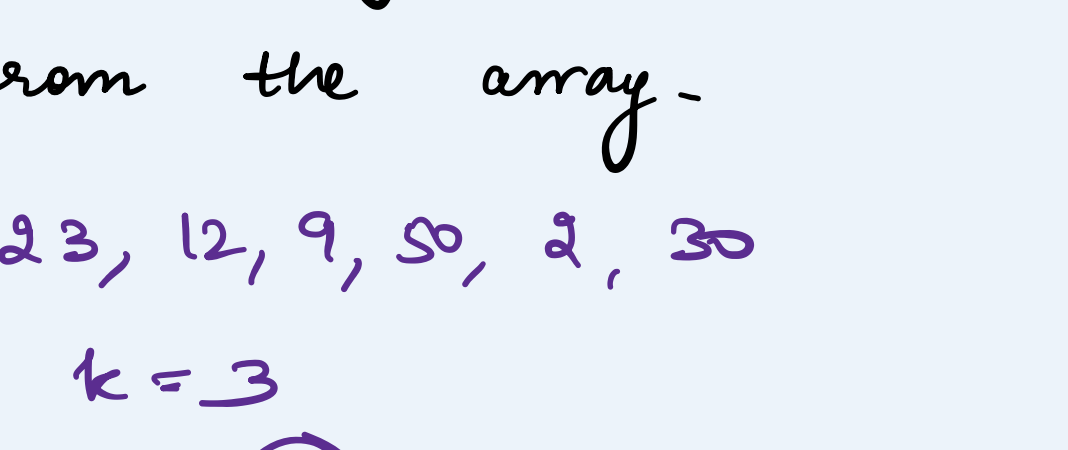
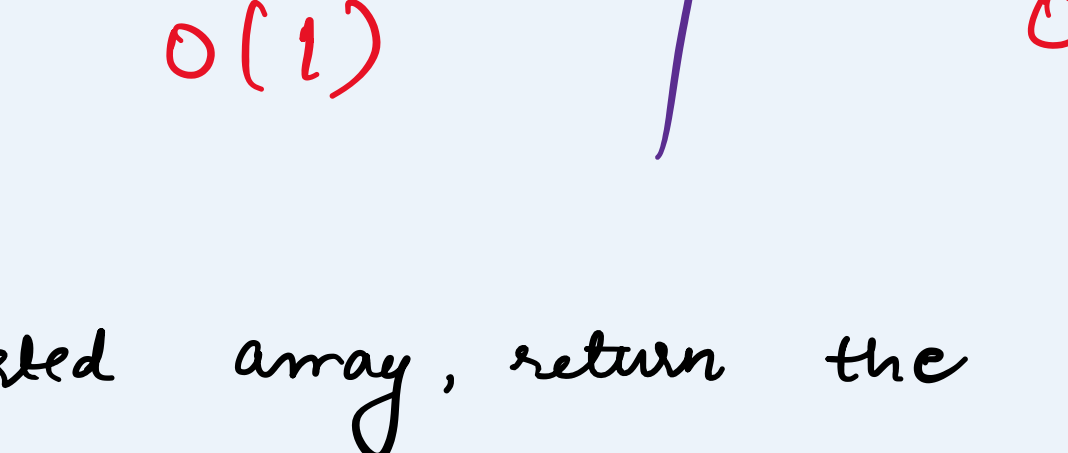
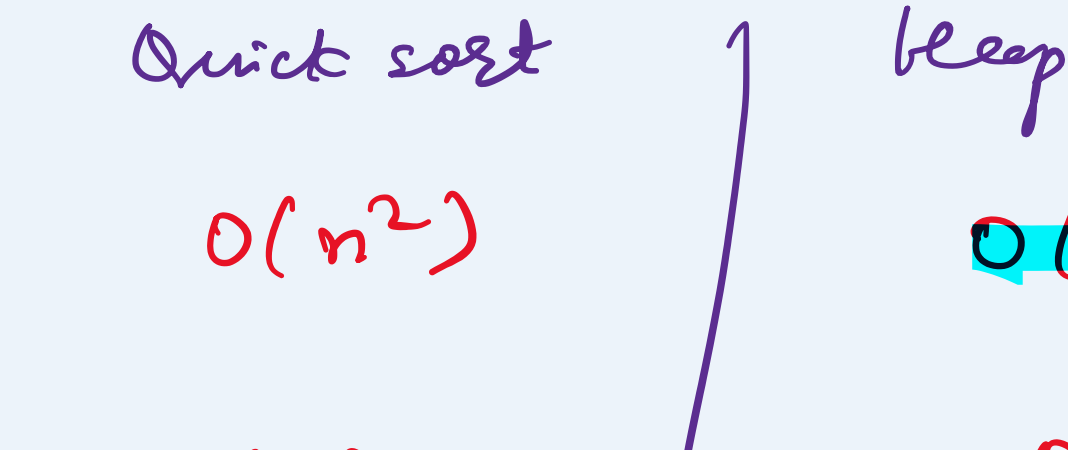
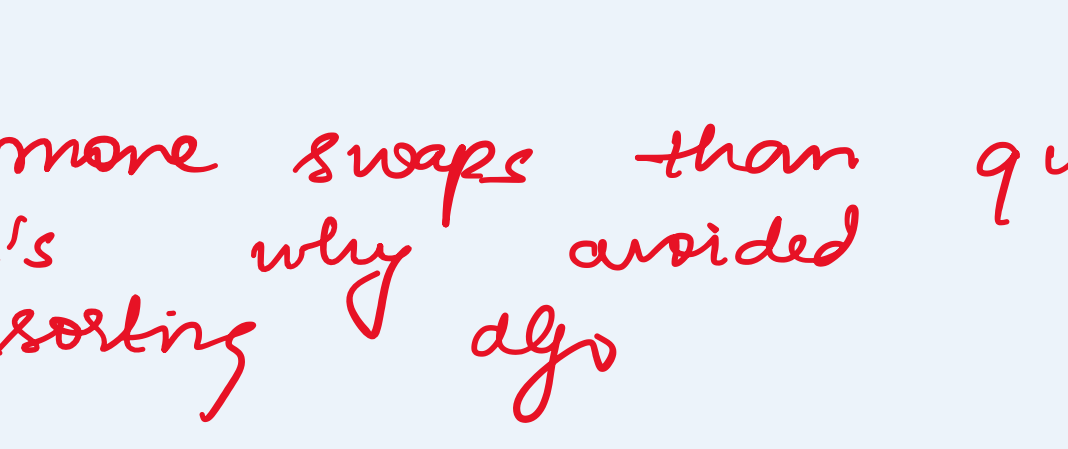
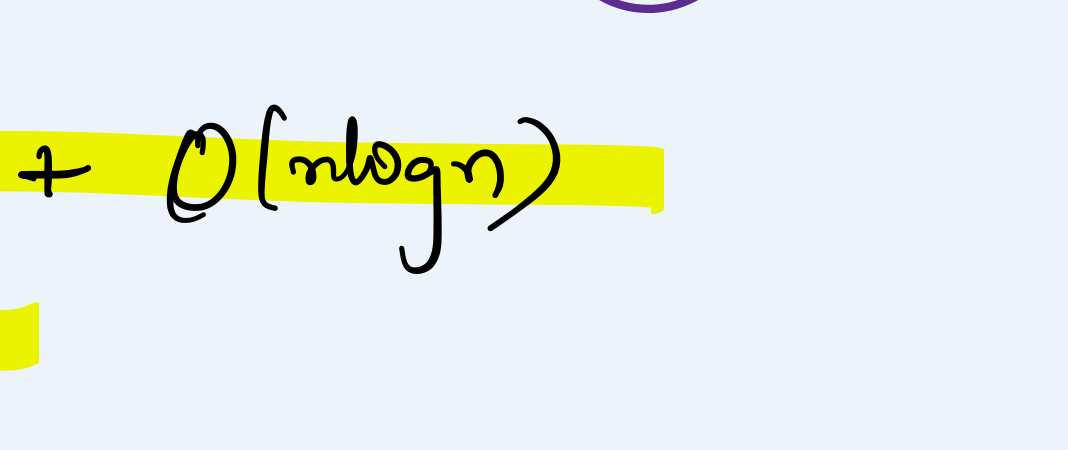
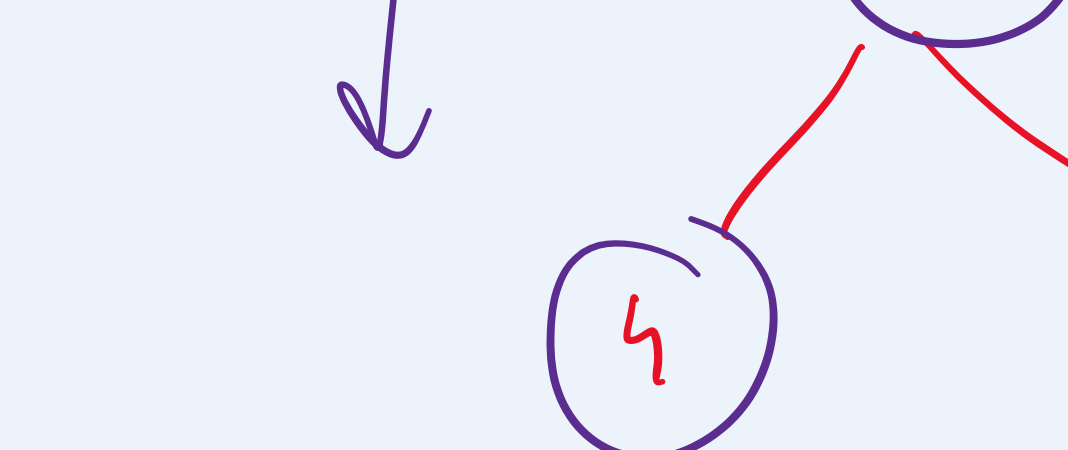
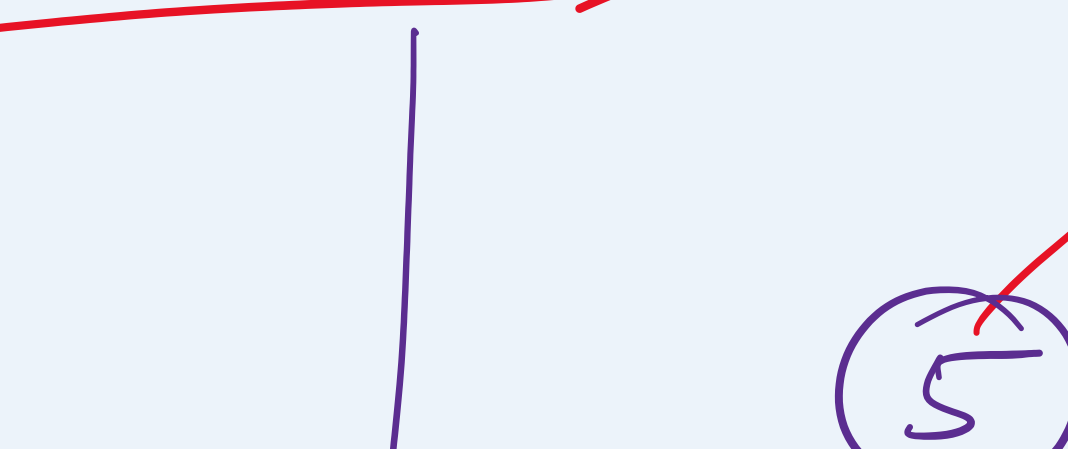
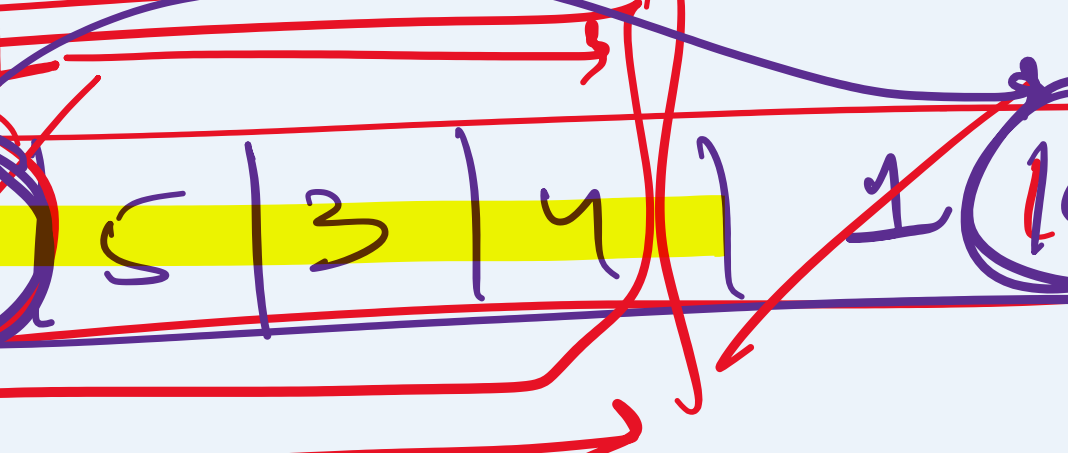
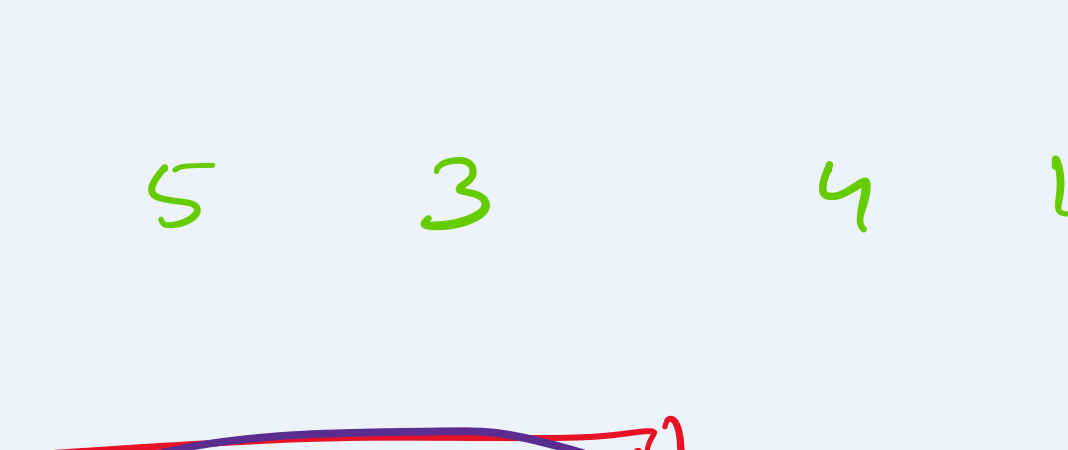
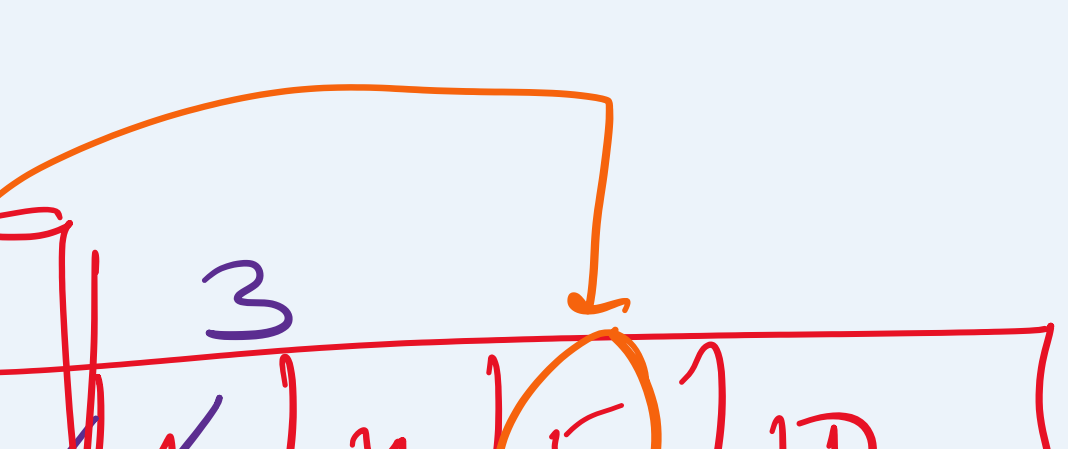
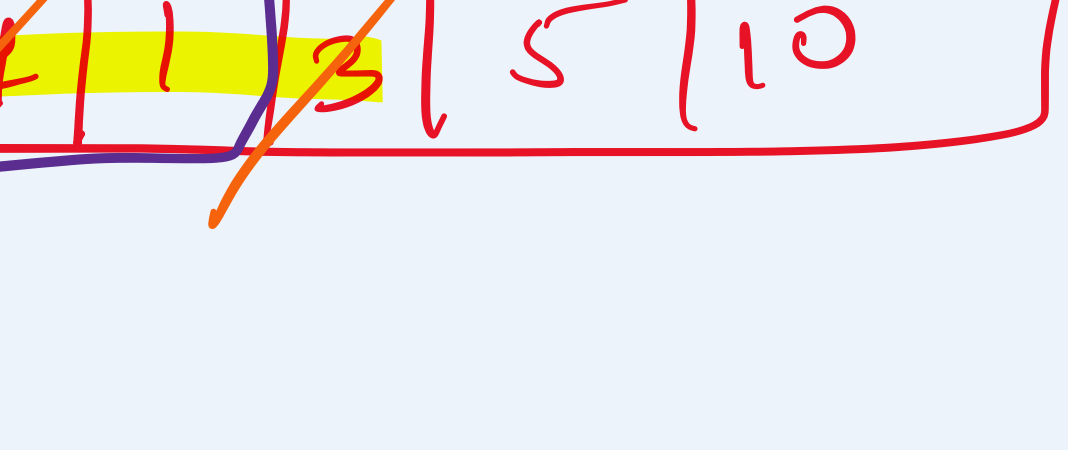
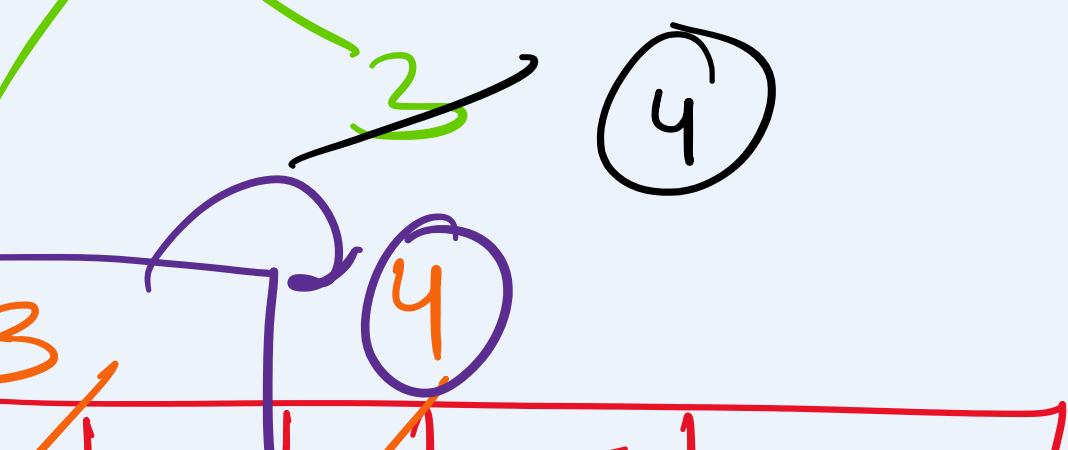
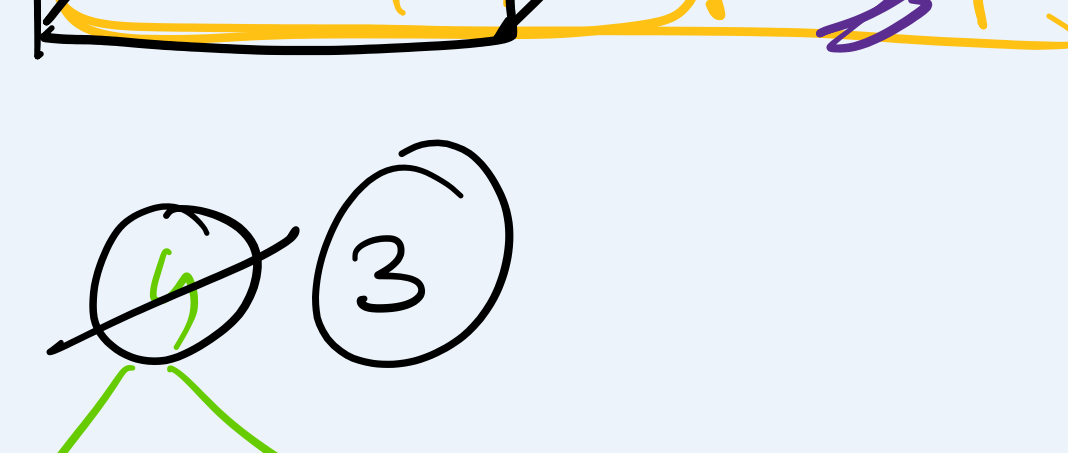


remove()

① swap (10 & 4)



swap (5 & 1)



TC $\rightarrow O(n) + O(n \log n)$

SC $\rightarrow O(1)$

Heap sort has more swaps than quick sort, that's why avoided in internal sorting algo

Merge Sort Quick sort Heap sort -

TC $\rightarrow O(n \log n)$ $O(n^2)$ $O(n \log n)$

SC $\rightarrow O(n)$ $O(1)$ $O(1)$

Q2 Given an unsorted array, return the k^{th} largest no. from the array.

Eg: $1, 23, 12, 9, 50, 2, 30$

$k=3$

ans $\rightarrow 23$

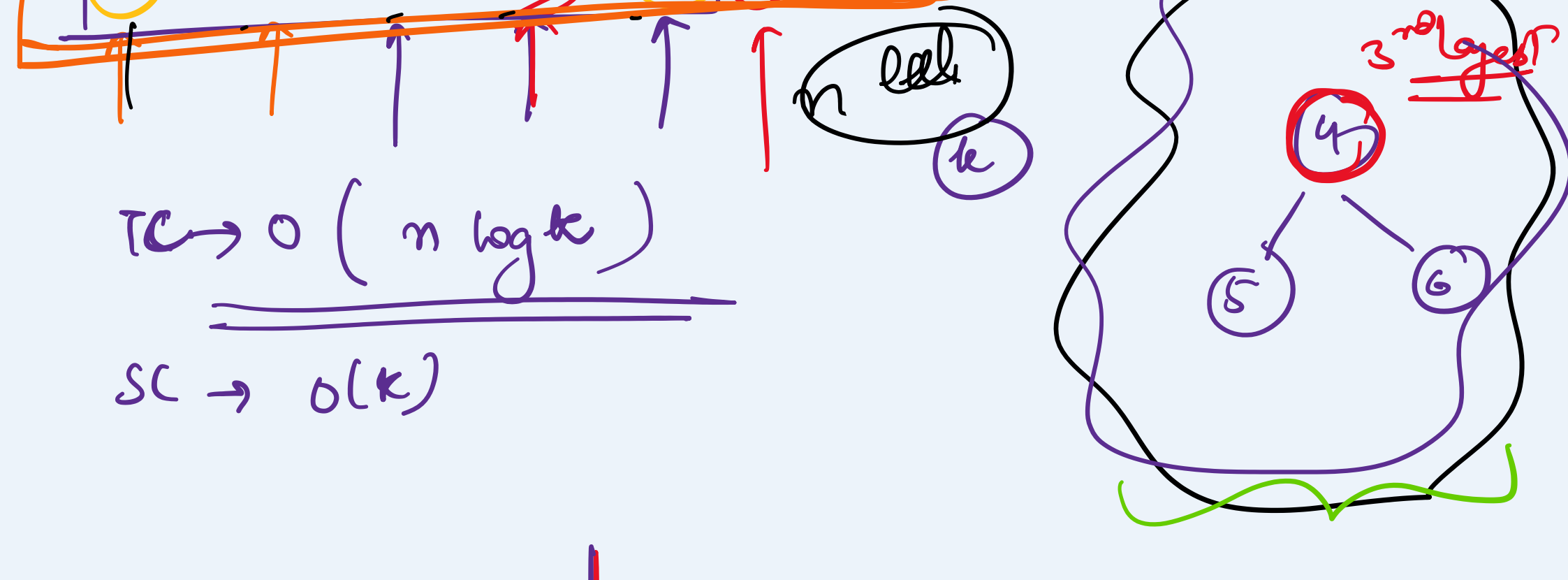
Approach (1) Max Heap

\rightarrow add all elements to max heap.
 $\rightarrow O(n \log n)$
 \rightarrow first remove $k-1$ ele.
 \rightarrow remove $\rightarrow 50$
 \rightarrow remove $\rightarrow 30$

\rightarrow remove \rightarrow ans $\rightarrow 23$

TC $\rightarrow O(n \log n)$

Approach (2): min Heap



TC $\rightarrow O(n \log k)$

SC $\rightarrow O(k)$



TC $\rightarrow O(n \log k)$

Q Given an unsorted array. Find the maximum difference b/w two subsets of m elements.

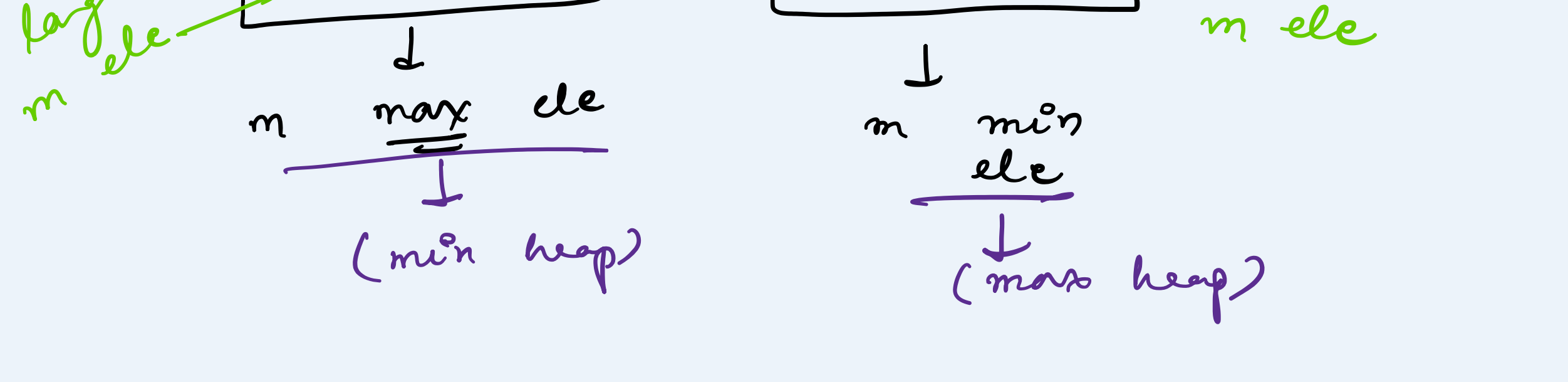
Eg: $1, 3, 2, 5, 4$ $m=4$

ans $\rightarrow 4$

$[3, 2, 4, 5]$ $[1, 3, 2, 4]$

$[14]$ $[10]$

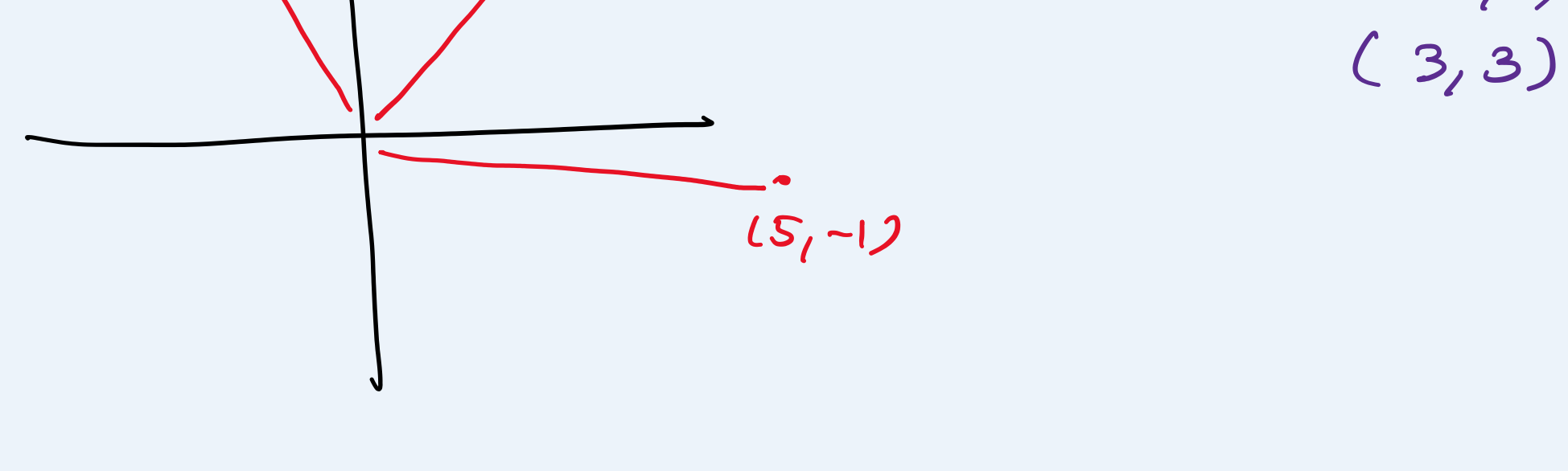
ans $\rightarrow 14 - 10 = 4$



Given an array of points

$[(3, 3), (5, -1), (2, 4)]$, $k=2$

k closest points to the origin.



Euclidean distance $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

ans $\rightarrow (-2, 4)$ $(3, 3)$

Min Heap

Q Given k -lists, sorted

$[1, 3, 7, 9, 15]$

$[2, 6, 10]$

$[10, 12]$

$[2, 7, 11, 14]$

Merge k -sorted lists

$[1, 2, 2, 3, 6, 7, 7, 9, 10, 10, 11, 12, 15, 14]$