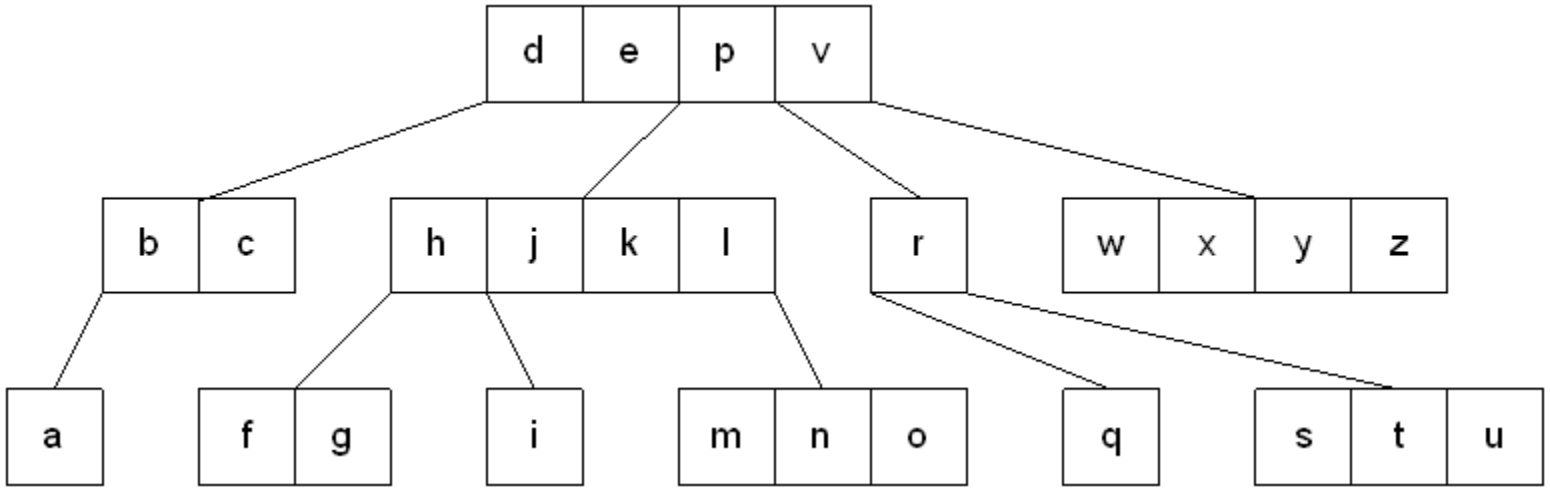
# M-way tree

Module-2

# M-way search tree:

- The **m-way** search trees are multi-way trees which are generalized versions of binary trees where each node contains multiple elements.
- In an m-way tree of order **m**, each node contains a maximum of **m – 1** elements and **m** children.
- Multiway tree of order 5




- Elements are present in ascending order at every level.

# M-way search tree:

- The goal of m-way search tree of height h calls for the search time complexity is $O(h)$.
- An m-way search tree of **n** elements ranges from a minimum height of $\mathbf{\log_m (n+1)}$ to a maximum of **n.**

Ex: Suppose you want to build a 3-way search tree (m = 3) with $n$=26 elements.

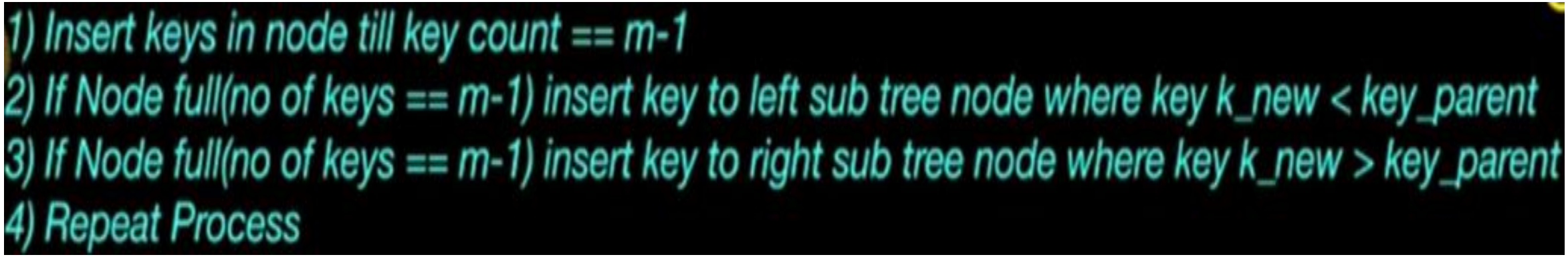
According to the formula: $h_{min} = \mathbf{\log_m (n+1)} = \mathbf{\log_3 (26+1)} = \mathbf{\log_3 (27) = 3}$

- The number of elements in an m-way search tree of height **h** ranges from a minimum of **h** to a maximum of $m^h$-1.

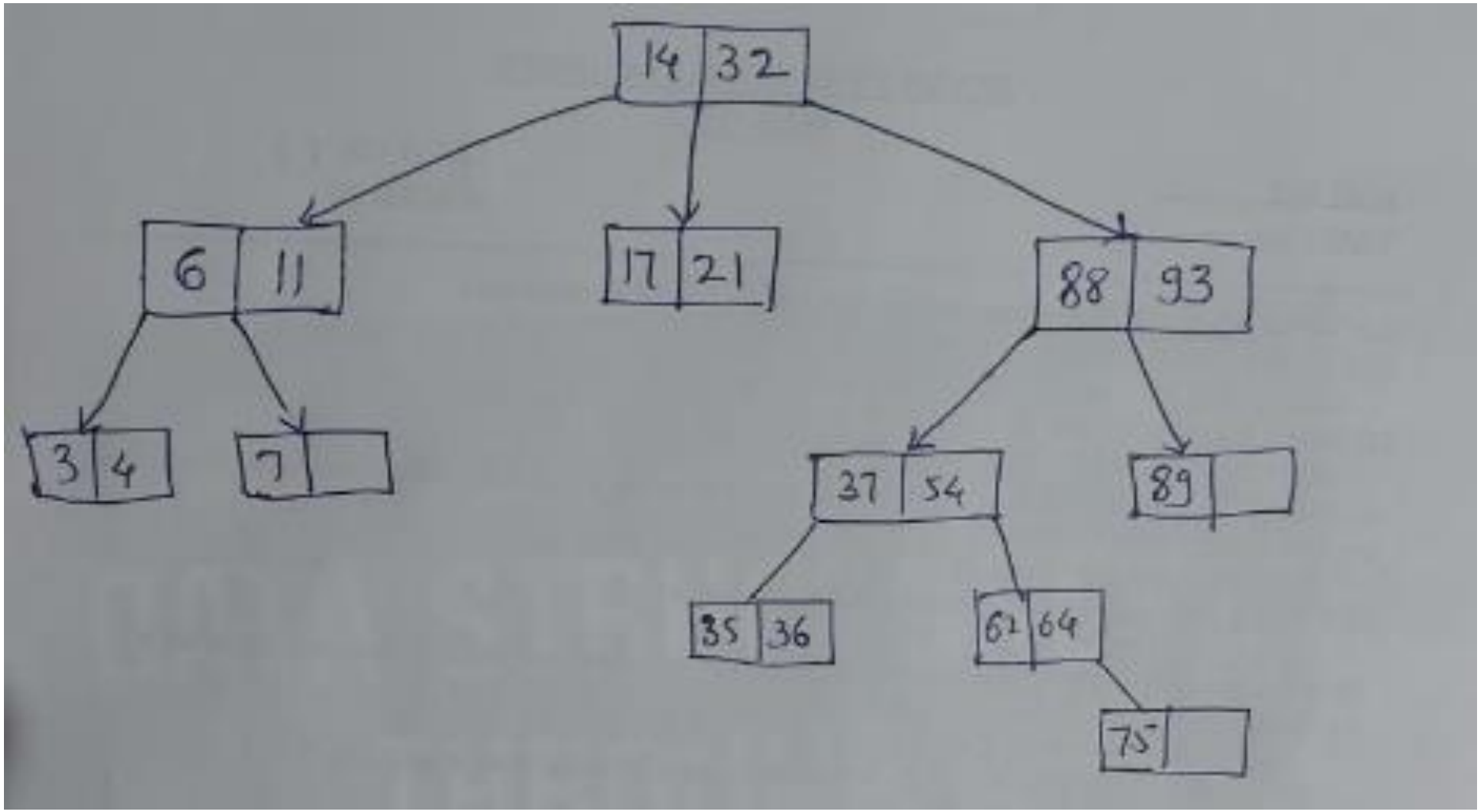
# Insertion in m-way tree

Eg. Create a m-way search tree with order=3.

Insert elements 14, 32, 11, 6, 7, 4, 3, 88, 93,54, 37, 21, 17, 89, 62, 64, 75, 35, 36



# Insertion in m-way tree



# Deletion in m-way tree

Case 1: Deletion of key with no subtrees --> Simply delete key from node

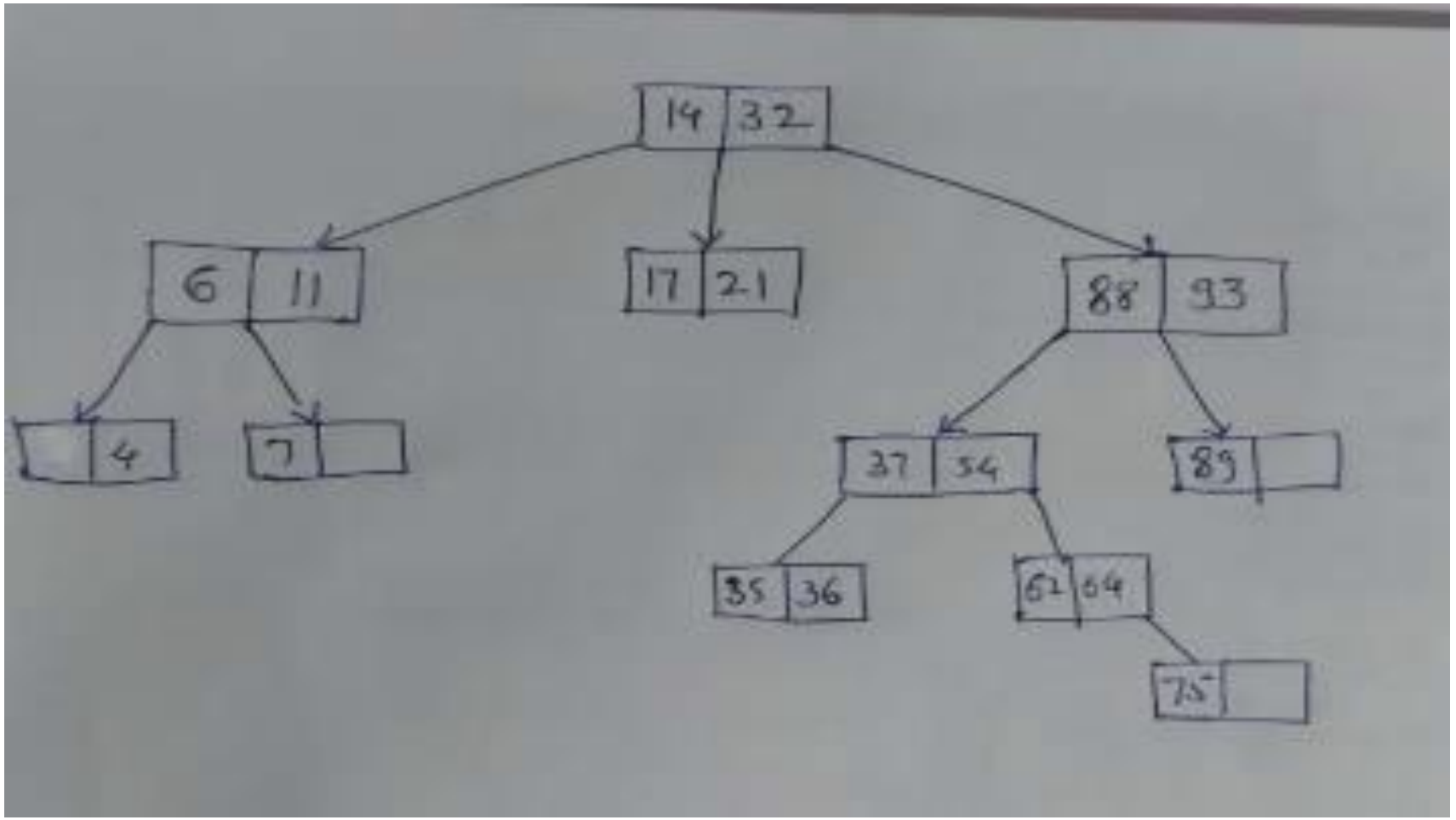
Case 2a: Deletion of key with left subtree --> Replace largest value from left subtree with value to be deleted. Delete largest value from left subtree.

Case 2b: Deletion of key with right subtree --> Replace smallest value from right subtree with value to be deleted. Delete smallest value from right subtree.

Case 3: Deletion of key with both left and right subtrees --> Replace smallest value for RST or Replace largest value from LST with the key value to be deleted. Then delete this replaced value.

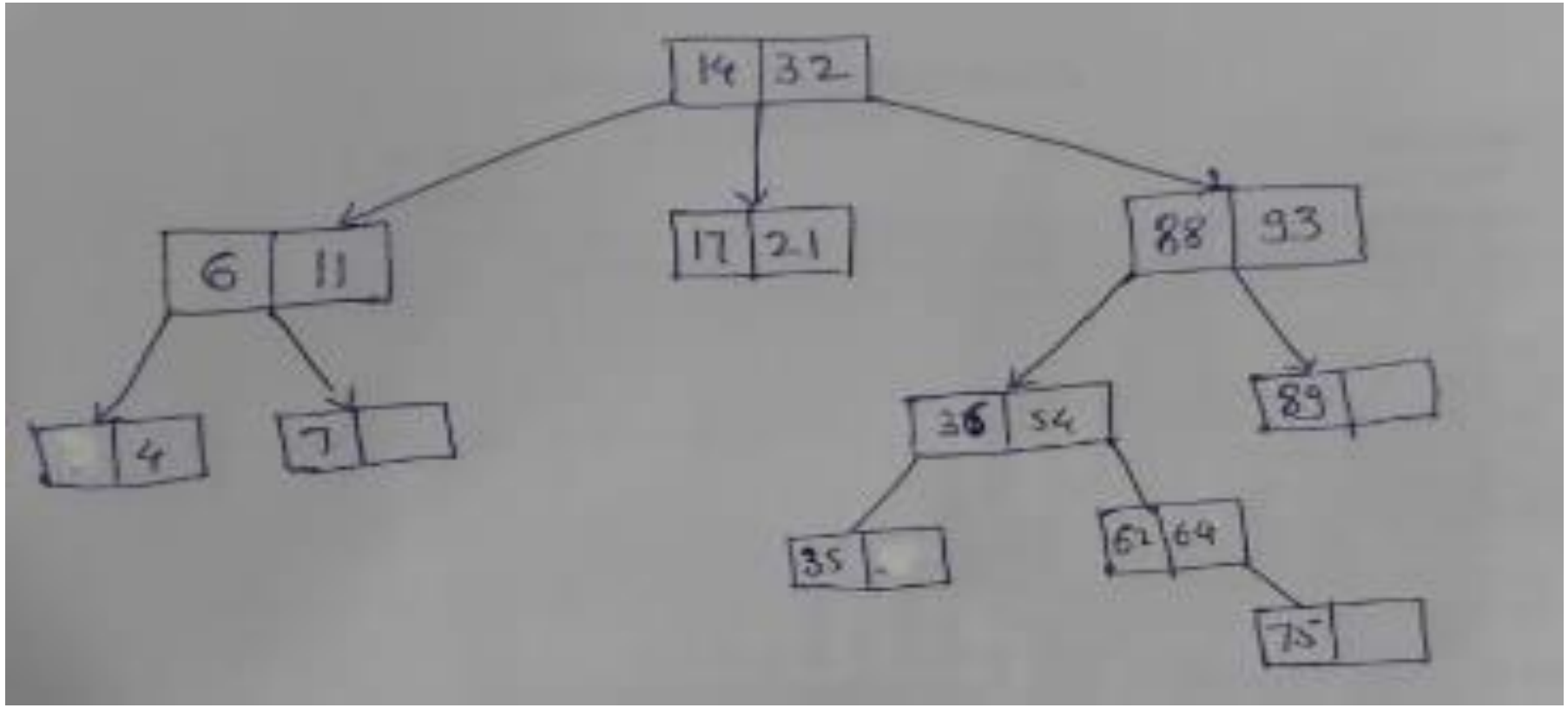
# Deletion in m-way tree

Delete 3 (case1)



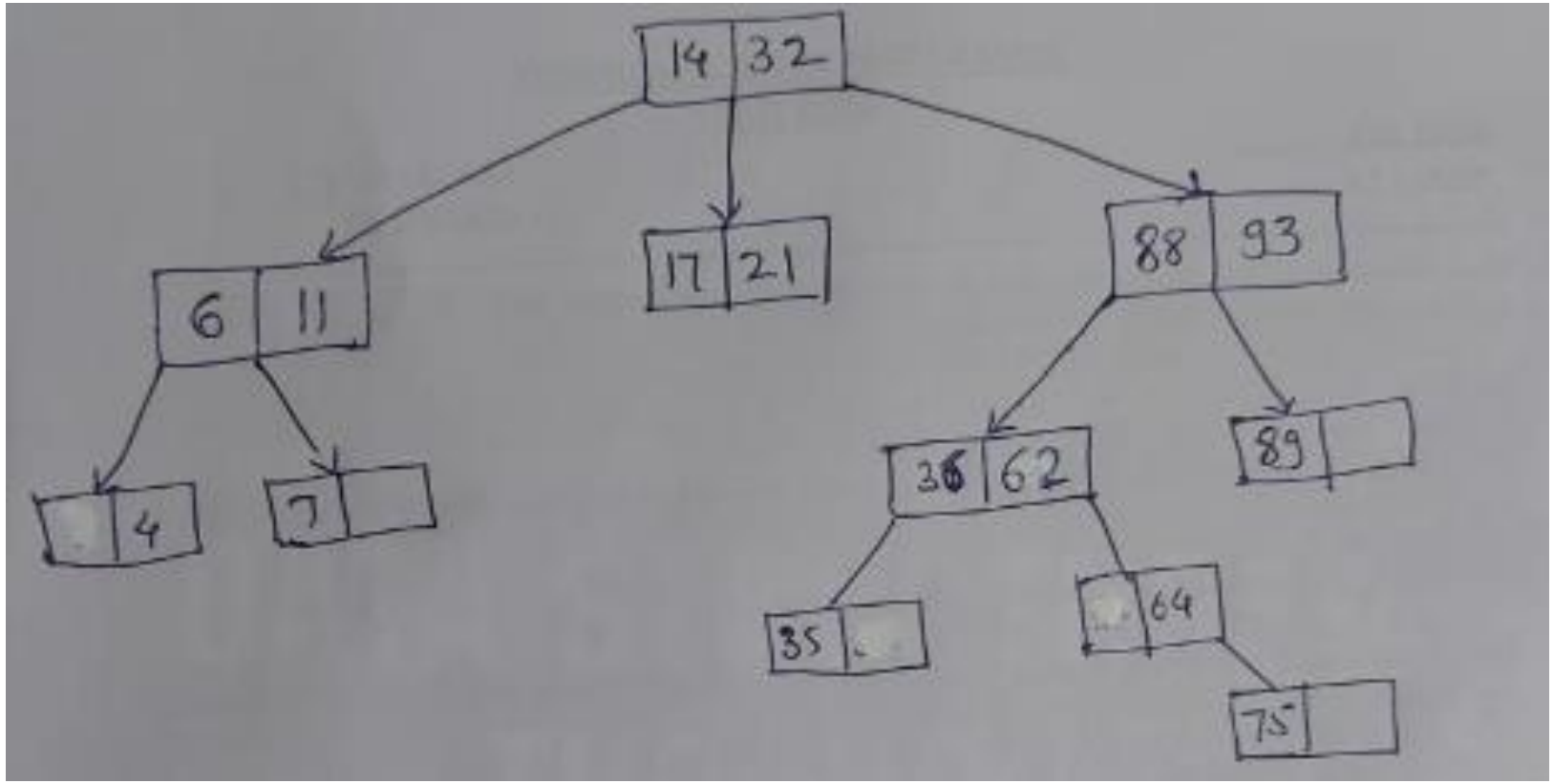
# Deletion in m-way tree

Delete 37 (case 2a)



# Deletion in m-way tree

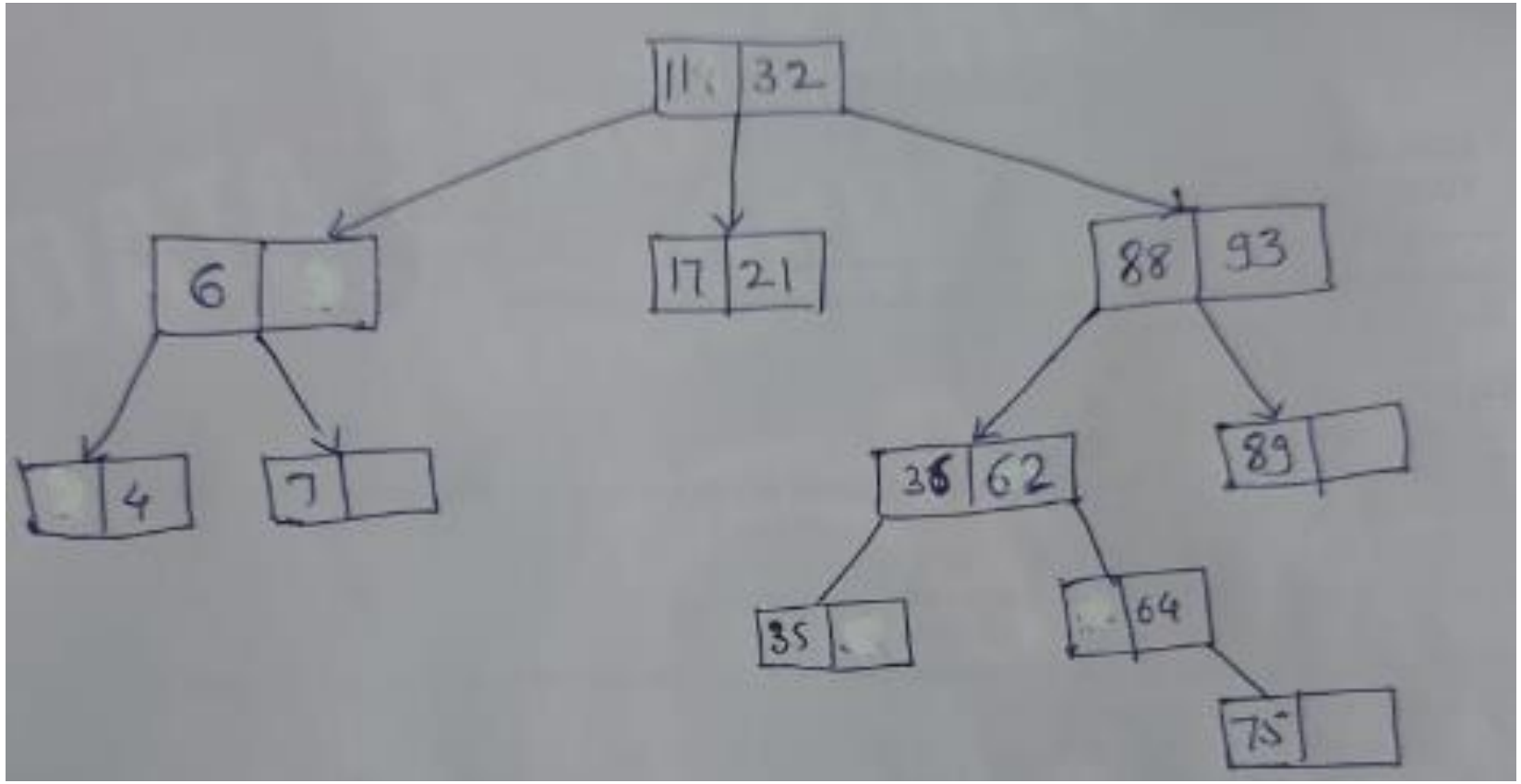
Delete 54 (case 2b)



# Deletion in m-way tree

Delete 14 (case 3)

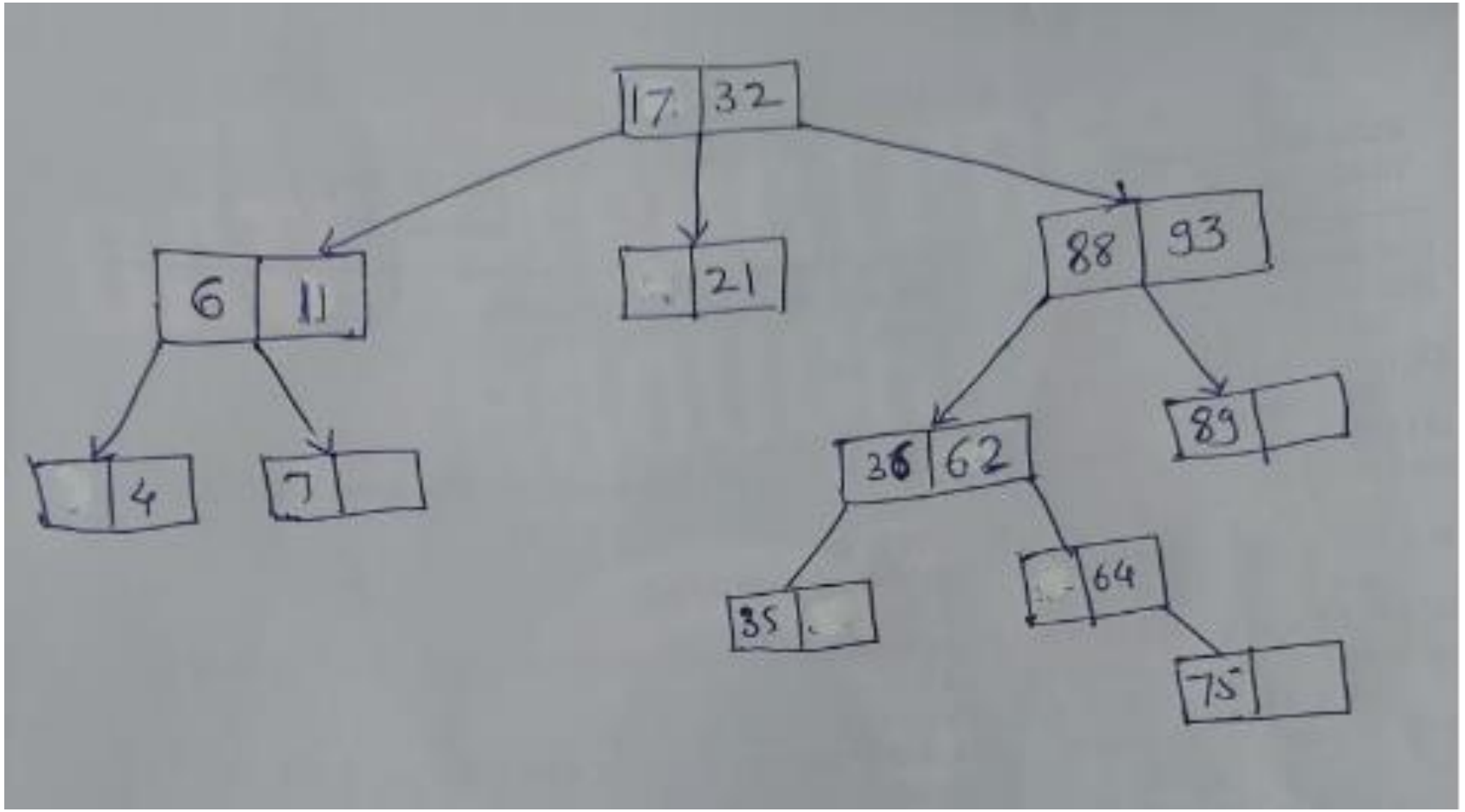
1st way to replace with largest value from left subtree



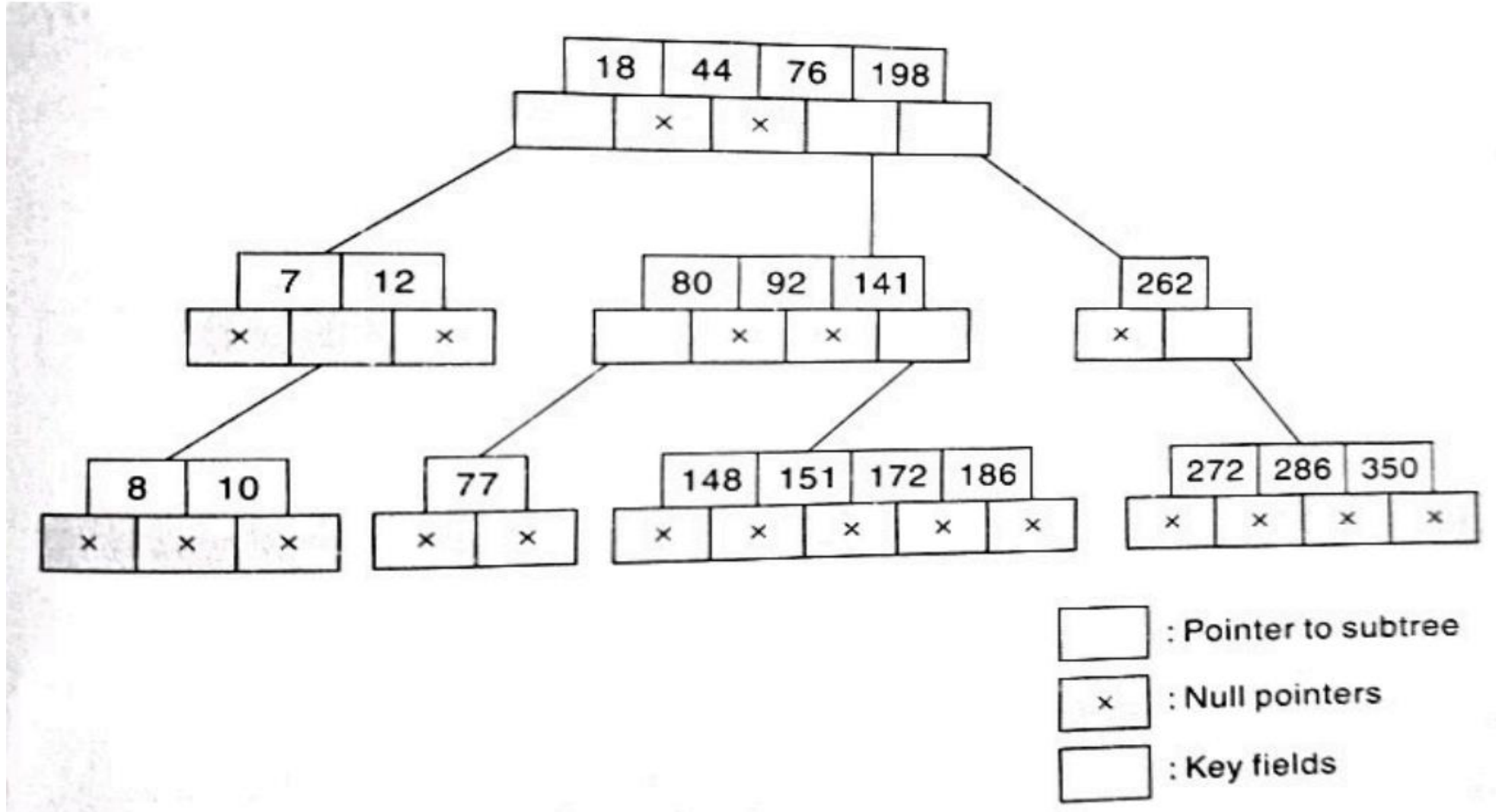
# Deletion in m-way tree

Delete 14 (case 3)

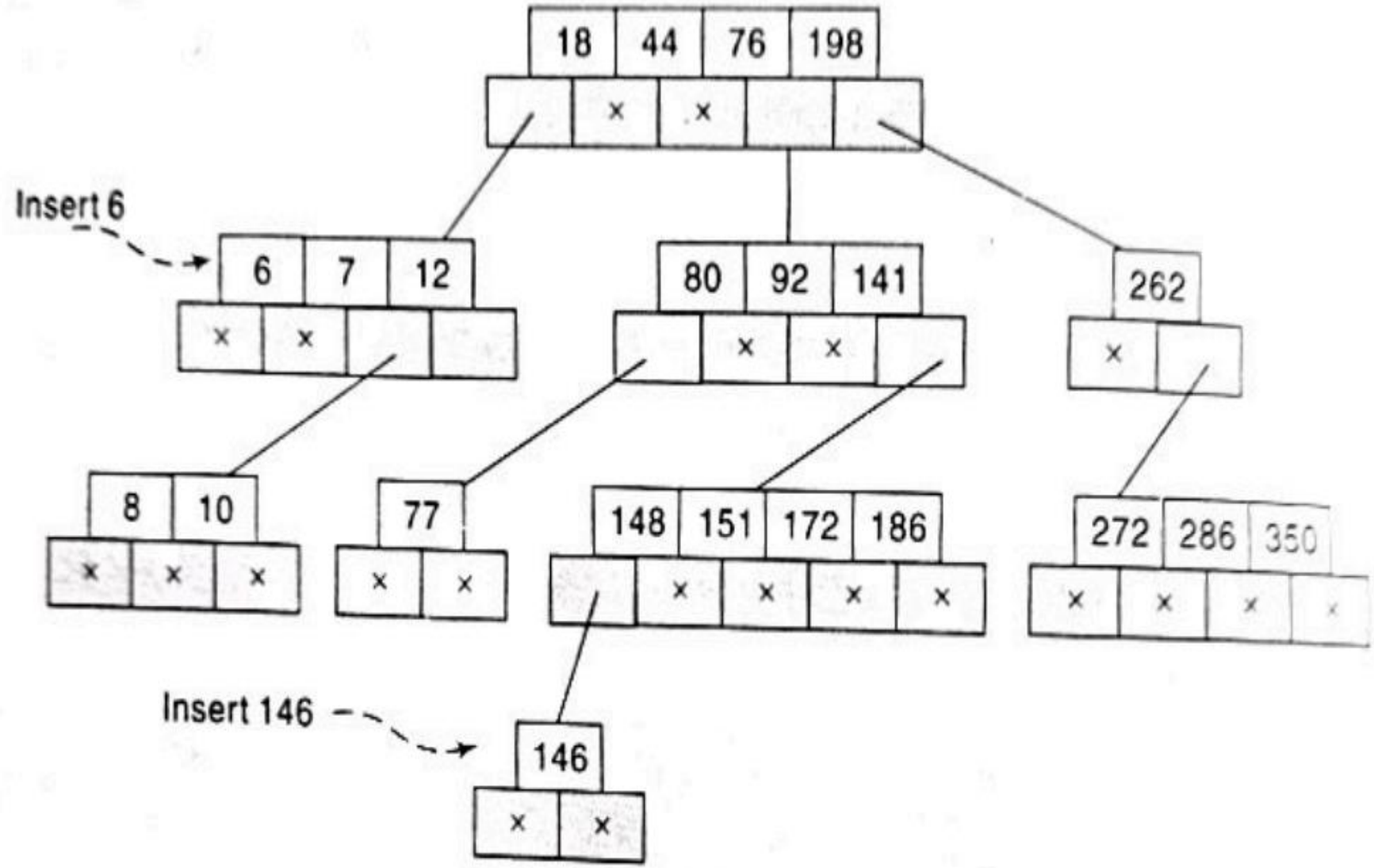
2nd way to replace with smallest value from right subtree



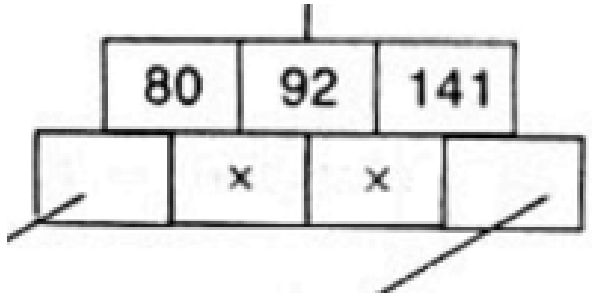
Given a following m-way tree. Insert 6 and 146 in above tree.



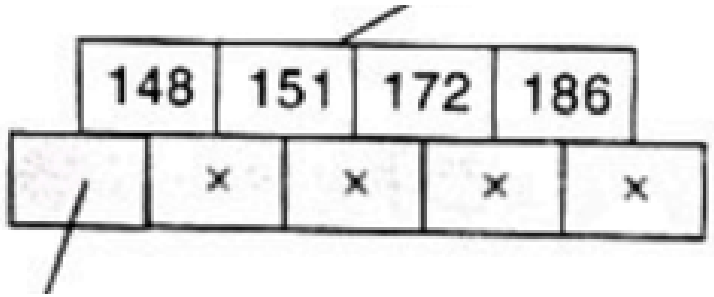
Given a following m-way tree. Insert 6 and 146 in above tree.



- Here we can not insert 146 in following node.




- Because if 146 will be added after 141 and this will lead to violation of property of m-way tree. In that case the following node will become left child of 146.




- Therefore we will add 146 as left child of above node(of key=148)