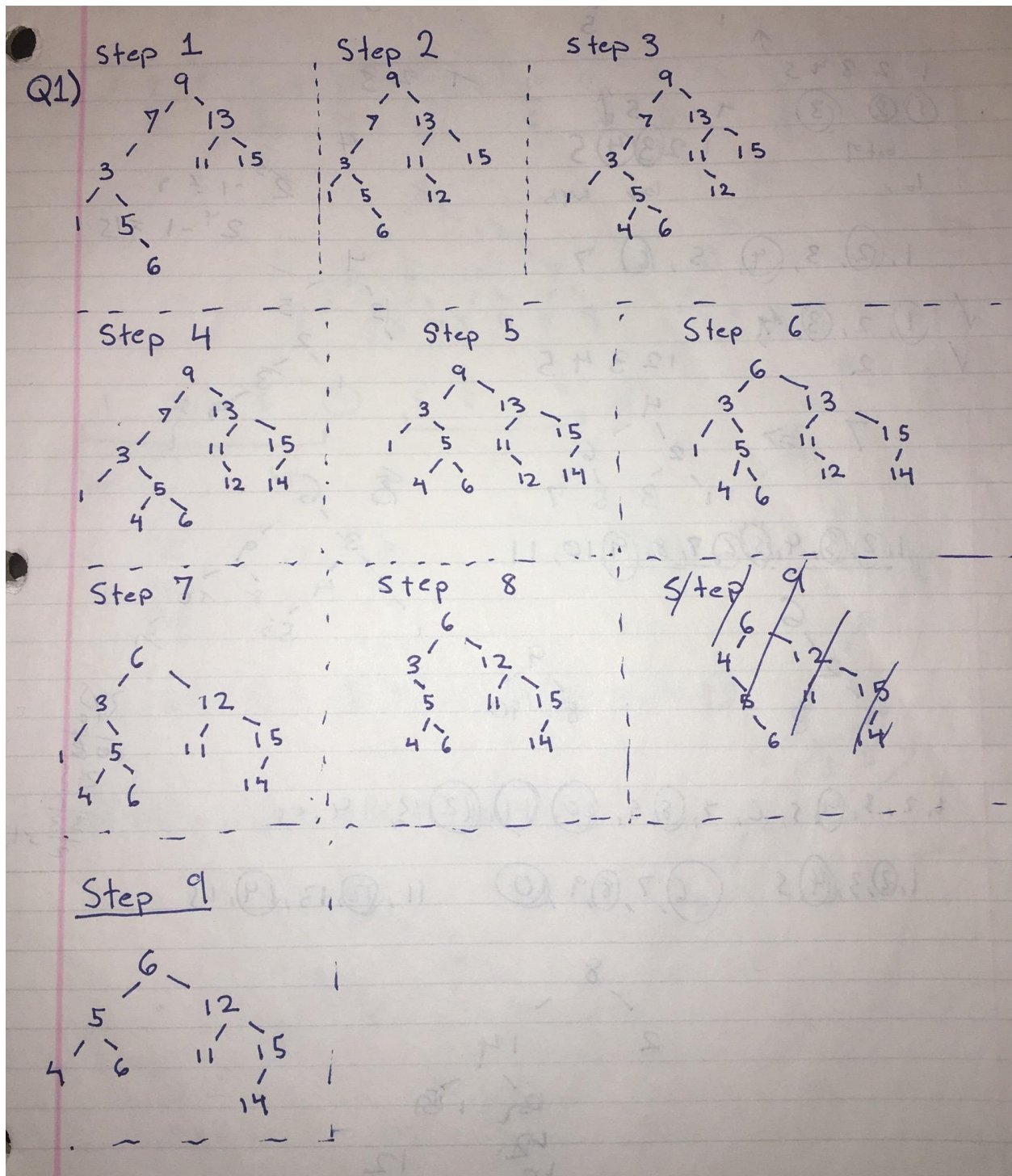


Q1:



Q2:

a)
2c) create_chain_bst(n):
 bst = BinarySearchTreeMap()
 for i in range(1, n+1):
 bst.subtree_insert(i)
 return bst

- create_chain_bst is $O(n)$ b/c it has
a for-loop that runs n times & inserts, which take $O(1)$.
 $O(n) \cdot O(1) = O(n)$

b) create_complete_bst(n):
 bst = BinarySearchTreeMap()
 add_items(bst, 1, n)
 return bst

add_items(bst, low, high)
 if low == high:
 bst.subtree_insert(low)
 else:

 mid = (low + high) // 2
 bst.subtree_insert(mid)
 if high - low != 1
 L = add_items(bst, low, mid-1)
 R = add_items(bst, mid+1, high)

add_items touch a range of numbers only once using
indexes making it $O(n)$ & inserts with a time of
 $O(1)$, meaning worst case is $O(n)$.

$O(n) \cdot O(1) = O(n)$

1) Actual Value

```
graph TD
    11((11)) --- 7((7))
    11 --- 13((13))
    7 --- 3((3))
    7 --- 9((9))
    3 --- 1((1))
    3 --- 5((5))
    13 --- 15((15))
```

height - balanced - value

```
graph TD
    1((1)) --- 1L((1))
    1 --- -1((-1))
    1L --- 0L((0))
    1L --- 0R((0))
    0L --- 0LL((0))
    0L --- 0LR((0))
    -1 --- 0R1((0))
```

11 insert 2

Left Rotation at 7

```
graph TD
    11((11)) --- 7((7))
    11 --- 13((13))
    7 --- 3((3))
    7 --- 9((9))
    3 --- 1((1))
    3 --- 5((5))
    1 --- 2((2))
```

Right Rotation at 3

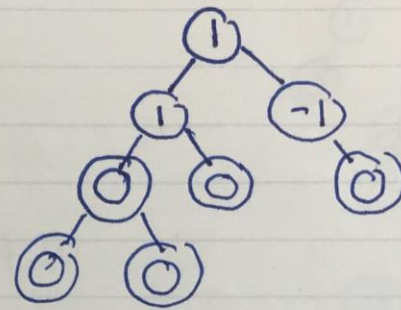
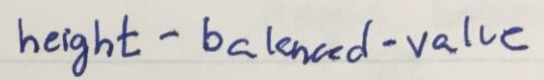
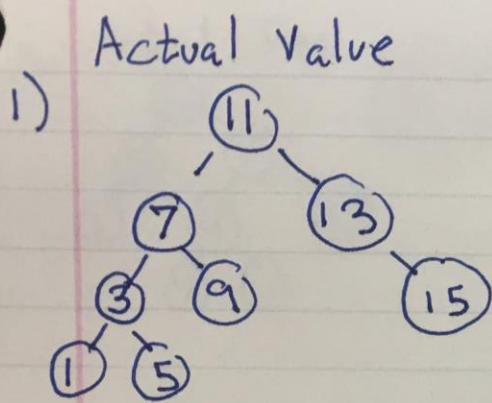
```
graph TD
    11((11)) --- 3((3))
    11 --- 13((13))
    3 --- 1((1))
    3 --- 7((7))
    1 --- 2((2))
    7 --- 5((5))
    7 --- 9((9))
    13 --- 15((15))
```

Left Rotation at 11

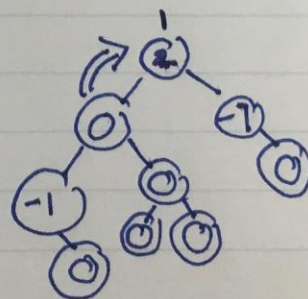
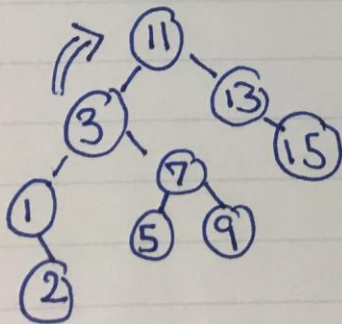
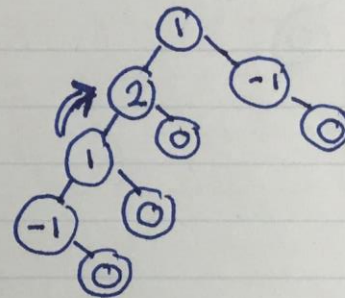
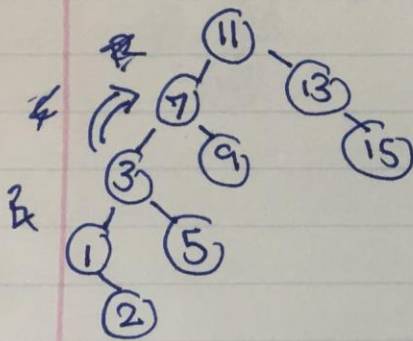
```
graph TD
    3((3)) --- 1((1))
    3 --- 7((7))
    1 --- 2((2))
    7 --- 5((5))
    7 --- 9((9))
    3 --- 11((11))
    3 --- 13((13))
    11 --- 15((15))
```

Right Rotation at 3

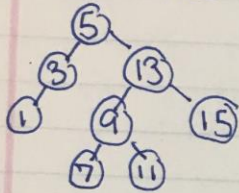
```
graph TD
    1((1)) --- 0L((0))
    1 --- -1((-1))
    0L --- 0LL((0))
    0L --- 0LR((0))
    -1 --- 0R1((0))
    0L --- 2((2))
    2 --- 0L1((0))
    2 --- 0R2((0))
    0L1 --- -1L1((-1))
    0R2 --- -1R2((-1))
    2 --- 11((11))
    2 --- 13((13))
    11 --- 15((15))
```



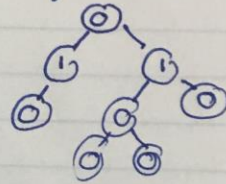
11 insert 2
✓



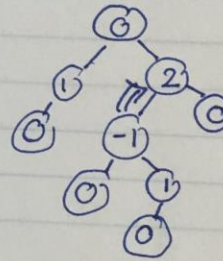
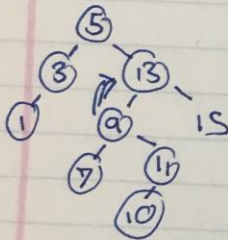
Actual Tree



Height balanced Value



⇓
insert 10



⇓

