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Q1. According to following Theorem (in page 274, Introduction to algorithm, CLRS)

***Theorem 11.6***
Given an open-address hash table with load factor $\alpha = n/m < 1$, the expected number of probes in an unsuccessful search is at most $1/(1-\alpha)$, assuming uniform hashing.

***Corollary 11.7***
Inserting an element into an open-address hash table with load factor $\alpha$ requires at most $1/(1-\alpha)$ probes on average, assuming uniform hashing.

***Theorem 11.8***
Given an open-address hash table with load factor $\alpha < 1$, the expected number of probes in a successful search is at most

$$\frac{1}{\alpha}\ln\frac{1}{1-\alpha} ,$$

assuming uniform hashing and assuming that each key in the table is equally likely to be searched for.

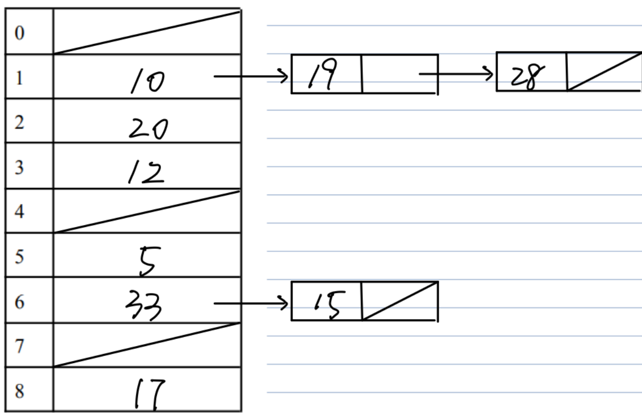
Proves of above theorem are given at books at page 274~275

According to above theorem, in most situations, the insertion and search complexity is $O(1)$. The expected cost is $O(1)$ when load factor $\ll 1$ (much smaller than 1). However, when load-factor approches 1, we need to expand the hash table and copy all the element. In this case, the cost is no longer $O(1)$ and would be linear in the number of elements stored instead.

Q2. Pseudocode:

```
Alg:RIGHT-ROTATE(tree, y):
    x = y.left
    y.left = x.right
    if (x.right != tree.nil):
        x.right.parent = y
    x.parent = y.parent
    if (y.parent == tree.nil):
        tree.root = x
    elif(y == y.parent.right):
        y.parent.right = x
    else:
        y.parent.left = x
    x.right = y
    y.parent = x
```

Q3. ① $h(5) = 5$ ② $h(28) = 1$ ③ $h(19) = 1$ ④ $h(15) = 6$ ⑤ $h(20) = 2$
⑥ $h(33) = 6$ ⑦ $h(12) = 3$ ⑧ $h(17) = 8$ ⑨ $h(10) = 1$




Q4. After Single Rotation:
Final Result: