HashMap in Java with Examples

- HashMap<K, V> is a part of Java's collection since Java 1.2. This class is found in java.util package. It provides the basic implementation of the Map interface of Java. It stores the data in (Key, Value) pairs, and you can access them by an index of another type (e.g. an Integer). One object is used as a key (index) to another object (value). If you try to insert the duplicate key, it will replace the element of the corresponding key.
  HashMap is similar to **HashTable**, but it is unsynchronized. It allows to store the null keys as well, but there should be only one null key object and there can be any number of null values. This class makes no guarantees as to the order of the map. To use this class and its methods, you need to import java.util.HashMap package or its superclass.

- Java

```java
// Java program to illustrate HashMap class of java.util
// package

// Importing HashMap class
import java.util.HashMap;

// Main class
public class GFG {

    // Main driver method
    public static void main(String[] args)
    {
        // Create an empty hash map by declaring object
        // of string and integer type
        HashMap<String, Integer> map = new HashMap<>();

        // Adding elements to the Map
        // using standard put() method
        map.put("vishal", 10);
        map.put("sachin", 30);
        map.put("vaibhav", 20);
```

```
        // Print size and content of the Map
        System.out.println("Size of map is:- "
                           + map.size());

        // Printing elements in object of Map
        System.out.println(map);

        // Checking if a key is present and if
        // present, print value by passing
        // random element
        if (map.containsKey("vishal")) {

            // Mapping
            Integer a = map.get("vishal");

            // Printing value for the corresponding key
            System.out.println("value for key"
                               + " \"vishal\" is:- " + a);
        }
    }
}
```

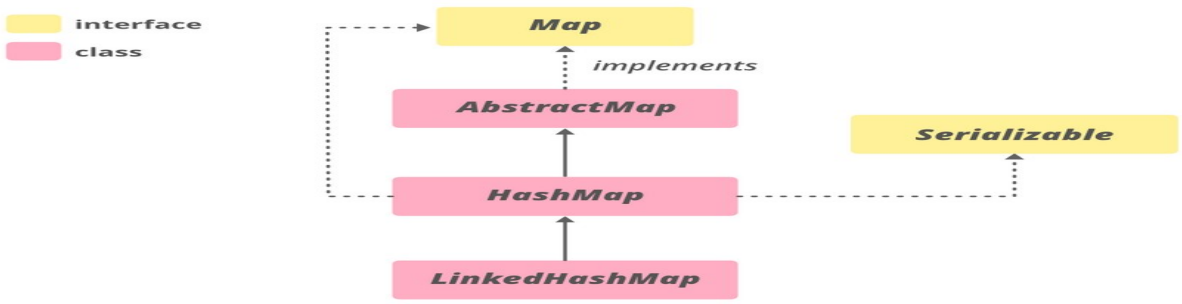
Output

```
Size of map is:- 3

{vaibhav=20, vishal=10, sachin=30}

value for key "vishal" is:- 10
```

The Hierarchy of HashMap is as follows:



Syntax: Declaration

```
public class HashMap<K,V> extends AbstractMap<K,V>
```

```
implements Map<K,V>, Cloneable, Serializable
```

Parameters: It takes two parameters namely as follows:

- The type of keys maintained by this map
- The type of mapped values

HashMap implements Serializable, Cloneable, **Map<K, V>** interfaces. HashMap extends AbstractMap<K, V> class. The direct subclasses are **LinkedHashMap**, PrinterStateReasons.

Constructors in HashMap is as follows:

HashMap provides 4 constructors and the access modifier of each is public which are listed as follows:

1. HashMap()
2. HashMap(int initialCapacity)
3. HashMap(int initialCapacity, float loadFactor)
4. HashMap(Map map)

Now discussing above constructors one by one alongside implementing the same with help of clean java programs.

Constructor 1: HashMap()
It is the default constructor which creates an instance of HashMap with an initial capacity of 16 and load factor of 0.75.

Syntax:

```
HashMap<K, V> hm = new HashMap<K, V>();
```

Example

- Java

```java
// Java program to Demonstrate the HashMap() constructor

// Importing basic required classes
import java.io.*;
import java.util.*;

// Main class
// To add elements to HashMap
class GFG {

    // Main driver method
    public static void main(String args[])
    {
        // No need to mention the
        // Generic type twice
        HashMap<Integer, String> hm1 = new HashMap<>();

        // Initialization of a HashMap using Generics
        HashMap<Integer, String> hm2
            = new HashMap<Integer, String>();

        // Adding elements using put method
        // Custom input elements
        hm1.put(1, "one");
        hm1.put(2, "two");
        hm1.put(3, "three");

        hm2.put(4, "four");
        hm2.put(5, "five");
        hm2.put(6, "six");

        // Print and display mapping of HashMap 1
        System.out.println("Mappings of HashMap hm1 are : "
                           + hm1);

        // Print and display mapping of HashMap 2
        System.out.println("Mapping of HashMap hm2 are : "
                           + hm2);
    }
}
```

Output

```
Mappings of HashMap hm1 are : {1=one, 2=two, 3=three}

Mapping of HashMap hm2 are : {4=four, 5=five, 6=six}
```

Constructor 2: HashMap(int initialCapacity)

It creates a HashMap instance with a specified initial capacity and load factor of 0.75.

Syntax:

```
HashMap<K, V> hm = new HashMap<K, V>(int initialCapacity);
```

Example

- Java

```java
// Java program to Demonstrate
// HashMap(int initialCapacity) Constructor

// Importing basic classes
import java.io.*;
import java.util.*;

// Main class
// To add elements to HashMap
class AddElementsToHashMap {

    // Main driver method
    public static void main(String args[])
    {
        // No need to mention the
        // Generic type twice
        HashMap<Integer, String> hm1 = new HashMap<>(10);

        // Initialization of a HashMap using Generics
        HashMap<Integer, String> hm2
            = new HashMap<Integer, String>(2);

        // Adding elements to object of HashMap
        // using put method

        // HashMap 1
        hm1.put(1, "one");
        hm1.put(2, "two");
        hm1.put(3, "three");

        // HashMap 2
        hm2.put(4, "four");
        hm2.put(5, "five");
        hm2.put(6, "six");

        // Printing elements of HashMap 1
        System.out.println("Mappings of HashMap hm1 are : "
                           + hm1);

        // Printing elements of HashMap 2
        System.out.println("Mapping of HashMap hm2 are : "
                           + hm2);
    }
```

```
}
```

Output

```
Mappings of HashMap hm1 are : {1=one, 2=two, 3=three}

Mapping of HashMap hm2 are : {4=four, 5=five, 6=six}
```

Constructor 3: HashMap(int initialCapacity, float loadFactor)

It creates a HashMap instance with a specified initial capacity and specified load factor.

Syntax:

```
HashMap<K, V> hm = new HashMap<K, V>(int initialCapacity, int loadFactor);
```

Example

- Java

```java
// Java program to Demonstrate
// HashMap(int initialCapacity,float loadFactor) Constructor

// Importing basic classes
import java.io.*;
import java.util.*;

// Main class
// To add elements to HashMap
class GFG {

    // Main driver method
    public static void main(String args[])
    {
        // No need to mention the generic type twice
        HashMap<Integer, String> hm1
            = new HashMap<>(5, 0.75f);

        // Initialization of a HashMap using Generics
        HashMap<Integer, String> hm2
            = new HashMap<Integer, String>(3, 0.5f);
```

```
        // Add Elements using put() method
        // Custom input elements
        hm1.put(1, "one");
        hm1.put(2, "two");
        hm1.put(3, "three");

        hm2.put(4, "four");
        hm2.put(5, "five");
        hm2.put(6, "six");

        // Print and display elements in object of hashMap 1
        System.out.println("Mappings of HashMap hm1 are : "
                           + hm1);

        // Print and display elements in object of hashMap 2
        System.out.println("Mapping of HashMap hm2 are : "
                           + hm2);
    }
}
```

Output

```
Mappings of HashMap hm1 are : {1=one, 2=two, 3=three}

Mapping of HashMap hm2 are : {4=four, 5=five, 6=six}
```

4. HashMap(Map map): It creates an instance of HashMap with the same mappings as the specified map.

HashMap<K, V> hm = new HashMap<K, V>(Map map);

- Java

```
// Java program to demonstrate the
// HashMap(Map map) Constructor

import java.io.*;
import java.util.*;

class AddElementsToHashMap {
    public static void main(String args[])
    {
        // No need to mention the
        // Generic type twice
        Map<Integer, String> hm1 = new HashMap<>();

        // Add Elements using put method
        hm1.put(1, "one");
        hm1.put(2, "two");
```

```
        hm1.put(3, "three");

        // Initialization of a HashMap
        // using Generics
        HashMap<Integer, String> hm2
            = new HashMap<Integer, String>(hm1);

        System.out.println("Mappings of HashMap hm1 are : "
                           + hm1);

        System.out.println("Mapping of HashMap hm2 are : "
                           + hm2);
    }
}
```

Output

```
Mappings of HashMap hm1 are : {1=one, 2=two, 3=three}

Mapping of HashMap hm2 are : {1=one, 2=two, 3=three}
```

Performing Various Operations on HashMap

1. Adding Elements: In order to add an element to the map, we can use the **put()** method. However, the insertion order is not retained in the Hashmap. Internally, for every element, a separate hash is generated and the elements are indexed based on this hash to make it more efficient.

- Java

```
// Java program to add elements
// to the HashMap

import java.io.*;
import java.util.*;

class AddElementsToHashMap {
    public static void main(String args[])
    {
        // No need to mention the
        // Generic type twice
        HashMap<Integer, String> hm1 = new HashMap<>();
```

```
        // Initialization of a HashMap
        // using Generics
        HashMap<Integer, String> hm2
            = new HashMap<Integer, String>();

        // Add Elements using put method
        hm1.put(1, "Geeks");
        hm1.put(2, "For");
        hm1.put(3, "Geeks");

        hm2.put(1, "Geeks");
        hm2.put(2, "For");
        hm2.put(3, "Geeks");

        System.out.println("Mappings of HashMap hm1 are : "
                           + hm1);
        System.out.println("Mapping of HashMap hm2 are : "
                           + hm2);
    }
}
```

Output

```
Mappings of HashMap hm1 are : {1=Geeks, 2=For, 3=Geeks}

Mapping of HashMap hm2 are : {1=Geeks, 2=For, 3=Geeks}
```

2. Changing Elements: After adding the elements if we wish to change the element, it can be done by again adding the element with the **put()** method. Since the elements in the map are indexed using the keys, the value of the key can be changed by simply inserting the updated value for the key for which we wish to change.

- Java

```
// Java program to change
// elements of HashMap

import java.io.*;
import java.util.*;
class ChangeElementsOfHashMap {
    public static void main(String args[])
    {
```

```
        // Initialization of a HashMap
        HashMap<Integer, String> hm
            = new HashMap<Integer, String>();

        // Change Value using put method
        hm.put(1, "Geeks");
        hm.put(2, "Geeks");
        hm.put(3, "Geeks");

        System.out.println("Initial Map " + hm);

        hm.put(2, "For");

        System.out.println("Updated Map " + hm);
    }
}
```

Output

```
Initial Map {1=Geeks, 2=Geeks, 3=Geeks}

Updated Map {1=Geeks, 2=For, 3=Geeks}
```

3. Removing Element: In order to remove an element from the Map, we can use the **remove()** method. This method takes the key value and removes the mapping for a key from this map if it is present in the map.

- Java

```
// Java program to remove
// elements from HashMap

import java.io.*;
import java.util.*;
class RemoveElementsOfHashMap{
    public static void main(String args[])
    {
        // Initialization of a HashMap
        Map<Integer, String> hm
            = new HashMap<Integer, String>();

        // Add elements using put method
        hm.put(1, "Geeks");
        hm.put(2, "For");
        hm.put(3, "Geeks");
        hm.put(4, "For");
```

```
        // Initial HashMap
        System.out.println("Mappings of HashMap are : "
                           + hm);

        // remove element with a key
        // using remove method
        hm.remove(4);

        // Final HashMap
        System.out.println("Mappings after removal are : "
                           + hm);
    }
}
```

Output

```
Mappings of HashMap are : {1=Geeks, 2=For, 3=Geeks, 4=For}

Mappings after removal are : {1=Geeks, 2=For, 3=Geeks}
```

4. Traversal of HashMap

We can use the Iterator interface to traverse over any structure of the Collection Framework. Since Iterators work with one type of data we use Entry< ? , ? > to resolve the two separate types into a compatible format. Then using the next() method we print the entries of HashMap.

- Java

```
// Java program to traversal a
// Java.util.HashMap

import java.util.HashMap;
import java.util.Map;

public class TraversalTheHashMap {
    public static void main(String[] args)
    {
        // initialize a HashMap
        HashMap<String, Integer> map = new HashMap<>();

        // Add elements using put method
        map.put("vishal", 10);
```

```
        map.put("sachin", 30);
        map.put("vaibhav", 20);

        // Iterate the map using
        // for-each loop
        for (Map.Entry<String, Integer> e : map.entrySet())
            System.out.println("Key: " + e.getKey()
                               + " Value: " + e.getValue());
    }
}
```

Output

```
Key: vaibhav Value: 20

Key: vishal Value: 10

Key: sachin Value: 30
```

Important Features of HashMap

To access a value one must know its key. HashMap is known as HashMap because it uses a technique called Hashing. **Hashing** is a technique of converting a large String to small String that represents the same String. A shorter value helps in indexing and faster searches. **HashSet** also uses HashMap internally.

Few important features of HashMap are:

- HashMap is a part of java.util package.
- HashMap extends an abstract class AbstractMap which also provides an incomplete implementation of Map interface.
- It also implements **Cloneable** and **Serializable** interface. K and V in the above definition represent Key and Value respectively.
- HashMap doesn’t allow duplicate keys but allows duplicate values. That means A single key can’t contain more than 1 value but more than 1 key can contain a single value.

- HashMap allows null key also but only once and multiple null values.
- This class makes no guarantees as to the order of the map; in particular, it does not guarantee that the order will remain constant over time. It is roughly similar to HashTable but is unsynchronized.

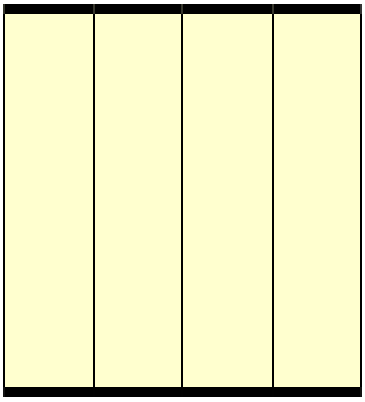
Internal Structure of HashMap

Internally HashMap contains an array of Node and a node is represented as a class that contains 4 fields:

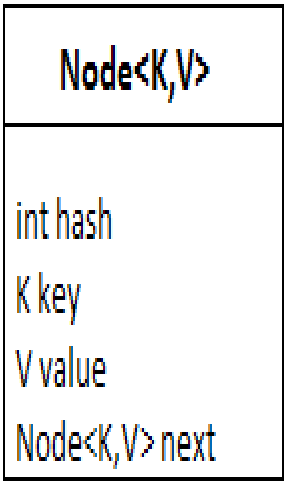
1. int hash
2. K key
3. V value
4. Node next

It can be seen that the node is containing a reference to its own object. So it’s a linked list.

HashMap:



Node:



Performance of HashMap

Performance of HashMap depends on 2 parameters which are named as follows:

1. Initial Capacity
2. Load Factor

1. Initial Capacity – It is the capacity of HashMap at the time of its creation (It is the number of buckets a HashMap can hold when the HashMap is instantiated). In java, it is 2^4=16 initially, meaning it can hold 16 key-value pairs.

2. Load Factor – It is the percent value of the capacity after which the capacity of Hashmap is to be increased (It is the percentage fill of buckets after which Rehashing takes place). In java, it is 0.75f by default, meaning the rehashing takes place after filling 75% of the capacity.

3. Threshold – It is the product of Load Factor and Initial Capacity. In java, by default, it is (16 * 0.75 = 12). That is, Rehashing takes place after inserting 12 key-value pairs into the HashMap.

4. Rehashing – It is the process of doubling the capacity of the HashMap after it reaches its Threshold. In java, HashMap continues to rehash(by default) in the following sequence – 2^4, 2^5, 2^6, 2^7, …. so on.

If the initial capacity is kept higher then rehashing will never be done. But by keeping it higher increases the time complexity of iteration. So it should be chosen very cleverly to increase performance. The expected number of values should be taken into account to set the initial capacity. The most generally preferred load factor value is 0.75 which provides a good deal between time and space costs. The load factor's value varies between 0 and 1.

> *Note: From Java 8 onward, Java has started using Self Balancing BST instead of a linked list for chaining. The advantage of self-balancing bst is, we get the worst case (when every key maps to the same slot) search time is O(Log n).*

Synchronized HashMap

As it is told that HashMap is unsynchronized i.e. multiple threads can access it simultaneously. If multiple threads access this class simultaneously and at least one thread manipulates it structurally then it is necessary to make it synchronized externally. It is done by synchronizing some object which encapsulates the map. If No such object exists then it can be wrapped around Collections.synchronizedMap() to make HashMap synchronized and avoid accidental unsynchronized access. As in the following example:

```
Map m = Collections.synchronizedMap(new HashMap(...));
```

Now the Map m is synchronized. Iterators of this class are fail-fast if any structure modification is done after the creation of iterator, in any way except through the iterator's remove method. In a failure of iterator, it will throw ConcurrentModificationException.

Time complexity of HashMap: HashMap provides constant time complexity for basic operations, get and put if the hash function is properly written and it disperses the elements properly among the buckets. Iteration over HashMap depends on the capacity of HashMap and a number of key-value pairs. Basically, it is directly proportional to the capacity + size. Capacity is the number of buckets in HashMap. So it is not a good idea to keep a high number of buckets in HashMap initially.

Applications of HashMap: HashMap is mainly the implementation of hashing. It is useful when we need efficient implementation of search, insert and delete operations. Please refer to the **applications of hashing** for details.

Methods in HashMap

- K – The type of the keys in the map.
- V – The type of values mapped in the map.

METHOD	DESCRIPTION
clear()	Removes all of the mappings from this map.
clone()	Returns a shallow copy of this HashMap instance: the keys and values themselves are not cloned.
compute(K key, BiFunction<? super K, ? super V,? extends V> remappingFunction)	Attempts to compute a mapping for the specified key and its current mapped value (or null if there is no current mapping).
computeIfAbsent(K key, Function<? super K,? extends V> mappingFunction)	If the specified key is not already associated with a value (or is mapped to null), attempts to compute its value using the given mapping function and enters it into this map unless null.

METHOD	DESCRIPTION
computeIfPresent(K key, BiFunction<? super K, ? super V,? extends V> remappingFunction)	If the value for the specified key is present and non-null, attempts to compute a new mapping given the key and its current mapped value.
containsKey(Object key)	Returns true if this map contains a mapping for the specified key.
containsValue(Object value)	Returns true if this map maps one or more keys to the specified value.
entrySet()	Returns a Set view of the mappings contained in this map.
get(Object key)	Returns the value to which the specified key is mapped, or null if this map contains no mapping for the key.
isEmpty()	Returns true if this map contains no key-value mappings.
keySet()	Returns a Set view of the keys contained in this map.
merge(K key, V value, BiFunction<? super V, ? super V,? extends V> remappingFunction)	If the specified key is not already associated with a value or is associated with null, associates it with the given non-null value.
put(K key, V value)	Associates the specified value with the specified key in this map.
putAll(Map<? extends K,? extends V> m)	Copies all of the mappings from the specified map to this map.
remove(Object key)	Removes the mapping for the specified key from this map if present.
size()	Returns the number of key-value mappings in this map.
values()	Returns a Collection view of the values contained in this map.

Methods inherited from class java.util.AbstractMap

METHOD	DESCRIPTION
equals()	Compares the specified object with this map for equality.
hashCode()	Returns the hash code value for this map.
toString()	Returns a string representation of this map.

Methods inherited from interface java.util.Map

METHOD	DESCRIPTION
equals()	Compares the specified object with this map for equality.
forEach(BiConsumer<? super K, ? super V> action)	Performs the given action for each entry in this map until all entries have been processed or the action throws an exception.
getOrDefault(Object key, V defaultValue)	Returns the value to which the specified key is mapped, or defaultValue if this map contains no mapping for the key.

METHOD	DESCRIPTION
hashCode()	Returns the hash code value for this map.
putIfAbsent(K key, V value)	If the specified key is not already associated with a value (or is mapped to null) associates it with the given value and returns null, else returns the current value.
remove(Object key, Object value)	Removes the entry for the specified key only if it is currently mapped to the specified value.
replace(K key, V value)	Replaces the entry for the specified key only if it is currently mapped to some value.
replace(K key, V oldValue, V newValue)	Replaces the entry for the specified key only if currently mapped to the specified value.
replaceAll(BiFunction<? super K, ? super V,? extends V> function)	Replaces each entry’s value with the result of invoking the given function on that entry until all entries have been processed or the function throws an exception.

Internal Working of HashMap in Java

- Difficulty Level : **Medium**
- Last Updated : 11 Jul, 2022
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article, we will see how the hashmap get and put method works internally. What operations are performed? How the hashing is done. How the value is fetched by key. How the key-value pair is stored.

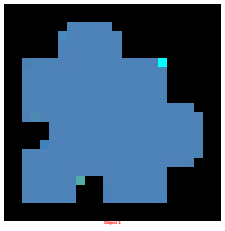
In the **previous article**, HashMap contains an array of Node and Node can represent a class having the following objects :

1. int hash
2. K key
3. V value
4. Node next

Now we will see how this works. First, we will see the hashing process.

Hashing

Hashing is a process of converting an object into integer form by using the method hashCode(). It's necessary to write the hashCode() method properly for better performance of HashMap. Here I am taking the key of my class so that I can override the hashCode() method to show different scenarios. My Key class is



```
//custom Key class to override hashCode()
// and equals() method
class Key
{
  String key;
  Key(String key)
  {
    this.key = key;
  }

  @Override
  public int hashCode()
  {
     return (int)key.charAt(0);
  }

  @Override
  public boolean equals(Object obj)
  {
    return key.equals((String)obj);
  }
}
```

Here override hashCode() method returns the first character’s ASCII value as hash code. So whenever the first character of the key is same, the hash code will be the same. You should not approach these criteria in your program. It is just for demo purposes. As HashMap also allows a null key, so hash code of null will always be 0.

hashCode() method: hashCode() method is used to get the hash code of an object. hashCode() method of the object class returns the memory reference of an object in integer form. Definition of hashCode() method is public native hashCode(). It indicates the implementation of hashCode() is native because there is not any direct method in java to fetch the reference of the object. It is possible to provide your implementation of hashCode().

In HashMap, hashCode() is used to calculate the bucket and therefore calculate the index.

equals() method: This method is used to check whether 2 objects are equal or not. This method is provided by the Object class. You can override this in your class to provide your implementation.

HashMap uses equals() to compare the key to whether they are equal or not. If the equals() method return true, they are equal otherwise not equal.

Buckets: It bucket is one element of the HashMap array. It is used to store nodes. Two or more nodes can have the same bucket. In that case, a link list structure is used to connect the nodes. Buckets are different in capacity. A relation between bucket and capacity is as follows:

```
capacity = number of buckets * load factor
```

A single bucket can have more than one node, it depends on the hashCode() method. The better your hashCode() method is, the better your buckets will be utilized.

Index Calculation in Hashmap

The Hash code of the key may be large enough to create an array. hash code generated may be in the range of integer and if we create arrays for such a range, then it will easily cause outOfMemoryException. So we generate an index to minimize the size of the array. The following operation is performed to calculate the index.

```
index = hashCode(key) & (n-1).
```

where n is the number of buckets or the size of the array. In our example, I will consider n as the default size which is 16.

Why the above method is used to calculate the index

Using a bitwise AND operator is similar to doing bit masking wherein only the lower bits of the hash integer is considered which in turn provides a very efficient method of calculating the modulus based on the length of the hashmap.

- Initially Empty hashMap: Here, the hashmap’s size is taken as 16.

```
HashMap map = new HashMap();
```

- HashMap :

- Inserting Key-Value Pair: Putting one key-value pair in the above HashMap

```
map.put(new Key("vishal"), 20);
```

- Steps:
  1. Calculate hash code of Key {“vishal”}. It will be generated as 118.
  2. Calculate index by using index method it will be 6.
  3. Create a node object as :

```
{
  int hash = 118

  // {"vishal"} is not a string but
  // an object of class Key
  Key key = {"vishal"}

  Integer value = 20
  Node next = null
}
```

1. Place this object at index 6, if no other object is presented there.

- Inserting another Key-Value Pair: Now, putting the other pair that is,

```
map.put(new Key("sachin"), 30);
```

- Steps:
  1. Calculate hashCode of Key {“sachin”}. It will be generated as 115.
  2. Calculate index by using index method it will be 3.
  3. Create a node object as :

```
{
```

```
  int hash = 115

  Key key = {"sachin"}

  Integer value = 30

  Node next = null

}
```

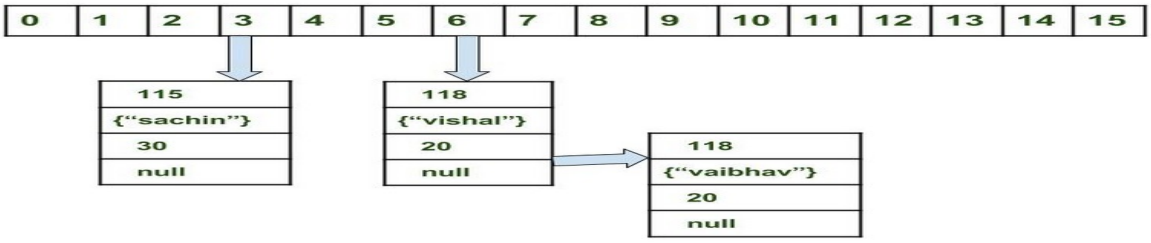
- In Case of collision: Now, putting another pair that is,

```
map.put(new Key("vaibhav"), 40);
```

- Steps:
  1. Calculate hash code of Key {“vaibhav”}. It will be generated as 118.
  2. Calculate index by using index method it will be 6.
  3. Create a node object as :

```
 {

  int hash = 118

  Key key = {"vaibhav"}

  Integer value = 40

  Node next = null

}
```

1. Place this object at index 6 if no other object is presented there.
2. In this case, a node object is found at index 6 – this is a case of collision.
3. In that case, check via the hashCode() and equals() method if both the keys are the same.
4. If keys are the same, replace the value with the current value.
5. Otherwise, connect this node object to the previous node object via linked list and both are stored at index 6.
   Now HashMap becomes :



Using the get method()

Now let’s try some get methods to get a value. get(K key) method is used to get a value by its key. If you don’t know the key then it is not possible to fetch a value.

- Fetch the data for key sachin:

```
map.get(new Key("sachin"));
```

- Steps:
  1. Calculate hash code of Key {“sachin”}. It will be generated as 115.
  2. Calculate index by using index method it will be 3.
  3. Go to index 3 of the array and compare the first element’s key with the given key. If both are equals then return the value, otherwise, check for the next element if it exists.
  4. In our case, it is found as the first element and the returned value is 30.
- Fetch the data for key vaibhav:

```
map.get(new Key("vaibhav"));
```

- Steps:
  1. Calculate hash code of Key {“vaibhav”}. It will be generated as 118.
  2. Calculate index by using index method it will be 6.

3. Go to index 6 of the array and compare the first element’s key with the given key. If both are equals then return the value, otherwise, check for the next element if it exists.
4. In our case, it is not found as the first element and the next node object is not null.
5. If the next node is null then return null.
6. If the next of node is not null traverse to the second element and repeat process 3 until the key is not found or next is not null.
7. Time complexity is almost constant for the put and the get method until rehashing is not done.
8. In case of collision, i.e. index of two or more nodes are the same, nodes are joined by a link list i.e. the second node is referenced by the first node and the third by the second, and so on.
9. If the key given already exist in HashMap, the value is replaced with the new value.
10. hash code of the null key is 0.
11. When getting an object with its key, the linked list is traversed until the key matches or null is found on the next field.