**Program:6a**

```
import java.util.Arrays;
public class CountingSort {
   public static void countingSort(int[] arr) {
      int max = Arrays.stream(arr).max().getAsInt();
      int min = Arrays.stream(arr).min().getAsInt();
      int range = max - min + 1;
     int[] count = new int[range];
      int[] output = new int[arr.length];
      for (int i = 0; i < arr.length; i++) {
         count[arr[i] - min]++;
      }
     for (int i = 1; i < count.length; i++) {
         count[i] += count[i - 1];
      }
      for (int i = arr.length - 1; i >= 0; i--) {
         output[count[arr[i] - min] - 1] = arr[i];
         count[arr[i] - min]--;}
      for (int i = 0; i < arr.length; i++) {
         arr[i] = output[i];
      }}
   public static void main(String[] args) {
      int[] arr = {4, 2, 2, 8, 3, 3, 1};
      System.out.println("Original Array: " + Arrays.toString(arr));
      countingSort(arr);
      System.out.println("Sorted Array:   " + Arrays.toString(arr));
   }}
```

**Output:**

```
Original Array: [4, 2, 2, 8, 3, 3, 1]
Sorted Array:   [1, 2, 2, 3, 3, 4, 8]
```

**Program:6b**

```
import java.util.Arrays;
public class RadixSort {
    public static int getMax(int[] arr) {
        int max = arr[0];
        for (int i = 1; i < arr.length; i++)
            if (arr[i] > max)
                max = arr[i];
        return max;
    }
    public static void countSort(int[] arr, int exp) {
        int n = arr.length;
        int[] output = new int[n];
        int[] count = new int[10];
        for (int i = 0; i < n; i++)
            count[(arr[i] / exp) % 10]++;
        for (int i = 1; i < 10; i++)
            count[i] += count[i - 1];
        for (int i = n - 1; i >= 0; i--) {
            int index = (arr[i] / exp) % 10;
            output[count[index] - 1] = arr[i];
            count[index]--;}
        for (int i = 0; i < n; i++)
            arr[i] = output[i];
    }
    public static void radixSort(int[] arr) {
        int max = getMax(arr);
        for (int exp = 1; max / exp > 0; exp *= 10)
            countSort(arr, exp);
    }
```

```
public static void main(String[] args) {
        int[] arr = {170, 45, 75, 90, 802, 24, 2, 66};
        System.out.println("Original Array: " + Arrays.toString(arr));
        radixSort(arr);
        System.out.println("Sorted Array:   " + Arrays.toString(arr));
    }
}
```

**Output:**

Original Array: [170, 45, 75, 90, 802, 24, 2, 66]

Sorted Array:  [2, 24, 45, 66, 75, 90, 170, 802]

**Program:6c**

```
import java.util.Arrays;
public class HeapSort {
    public static void heapify(int[] arr, int n, int i) {
        int largest = i;
        int left = 2 * i + 1;
        int right = 2 * i + 2;
        if (left < n && arr[left] > arr[largest])
            largest = left;
        if (right < n && arr[right] > arr[largest])
            largest = right;
        if (largest != i) {
            int swap = arr[i];
            arr[i] = arr[largest];
            arr[largest] = swap;
            heapify(arr, n, largest);
        }}
    public static void heapSort(int[] arr) {
        int n = arr.length;
        for (int i = n / 2 - 1; i >= 0; i--)
            heapify(arr, n, i);
        for (int i = n - 1; i > 0; i--) {
            int temp = arr[0];
            arr[0] = arr[i];
            arr[i] = temp;
            heapify(arr, i, 0);
        }
    }
    public static void main(String[] args) {
        int[] arr = {12, 11, 13, 5, 6, 7};
```

```
        System.out.println("Original Array: " + Arrays.toString(arr));
        heapSort(arr);
        System.out.println("Sorted Array:   " + Arrays.toString(arr));
    }
}
```

**Output:**

Original Array: [12, 11, 13, 5, 6, 7]

Sorted Array:   [5, 6, 7, 11, 12, 13]