Problem 1  A generic priority queue is implemented as a heap so that \( n \) entries of comparable type \( K \) occupy elements 1, 2, 3, \ldots \((n + 1)\) of an array \( data \) in the heap. Usual heap order and heap shape requirements are in force. (Note this uses slightly different array elements from the implementation described in class and in the textbook.) A skeleton for the class is as follows:

```java
public class HeapPriorityQueue // class title line to be completed as (a) {
    private K data[]; private int size = 0; private int capacity = 100;
    // constructor to be coded as (b)
    public void insert(K x) throws Exception {
        if (size >= capacity - 2) throw new Exception("Priority Queue Full");
        data[++size] = x;
        bubbleUp(size);
    }
    public K removeMin() throws Exception { // omitted
        private void swapData(int n, int m) { // omitted, swaps entries n and m
            private void bubbleUp(int n) { // omitted to be coded as (c)
                private void bubbleDown(int n) { // omitted
            }
        }
    }
    // constructor to be coded as (b)
    public HeapPriorityQueue() {
        data = (K[]) new Comparable[capacity];
    }
    // method bubbleUp
    private void bubbleUp(int n) {
        if (n <= 1) return;
        K node = data[n];
        K parent = data[n / 2];
        if (node.compareTo(parent) >= 0) return;
        swapData(n, n / 2);
        bubbleUp(n / 2);
    }
}
```

(a) Write the complete class title line, including a clause that makes it implement a \( PriorityQueue \).

Answer:

```java
public class HeapPriorityQueue<K extends Comparable<K>> implements PriorityQueue<K>
```

(b) Implement a constructor with no arguments.

Answer:

```java
public HeapPriorityQueue() {
    data = (K[]) new Comparable[capacity];
}
```

(c) Implement the method \( bubbleUp \).

Answer:

```java
private void bubbleUp(int n) {
    if (n <= 1) return;
    K node = data[n];
    K parent = data[n / 2];
    if (node.compareTo(parent) >= 0) return;
    swapData(n, n / 2);
    bubbleUp(n / 2);
}
```