Interfaces
You may assume for this problem that the instance variables of a Bag class implemented with a linked list are head and manyNodes. head is a reference to Node<E> with nodes having data components of type E. manyNodes is an integer indicating the number of items in the bag.

Assume that the LinkedBag class implements the Iterable interface – that means it has a method with the interface

```
public Iterator<E> iterator()
```

a. Write a code segment that obtains an Iterator from a LinkedBag<Integer> object called items (this object already exists), and then iterates through the container displaying every element that is greater than or equal to 10.

Remember the three methods in the interface for Iterator before writing this code (you will get some points for at least identifying these)!

```
Iterator<Integer> it = items.iterator();
while (it.hasNext()) {
    Integer num = it.next();
    if (num >= 10)
        System.out.print(num + " ");
}
```
Stacks and Queues

a. Write Java code for `public E remove()` for a generic queue implemented with a “circular” array as described in the text and lecture. Don’t forget about the `nextIndex` method (you can assume that you have this available to you).

```java
public E remove() {
    E answer;
    if (manyItems == 0)
        throw new NoSuchElementException("Queue underflow");
    answer = data[front];
    front = nextIndex(front);
    manyItems--;
    return answer;
}
```

b. Use a stack to evaluate the following postfix expression. Show your work so that I can see you are using a stack. You will not receive full credit without appropriate stack pictures. You may not use calculators.

```
7 3 + 4 5 * 4 2 + - 3 * 6 / +
```

```
          2
    5   4   4   6   3   6
3   4   20  20  20  14  14  42  42  7
7  7  10  10  10  10  10  10  10  10  10  17
-- -- -- -- -- -- -- -- -- -- -- --
Intellectual property.

a. What do you need to do to copyright material you put on your web pages?
Nothing – if you have created it and publish it on your website, you own the copyright

b. Give two requirements for obtaining a patent on a software application.
Non-obviousness
utility
originality

Recursion
For this question, you will write two versions of a function: one iterative and one recursive. The functions will take in two integer parameters named little and big. The function prototype for both functions is:

```java
void pattern(int little, int big)
```

When little is 1 and big is 5, the pattern is 5 4 3 2 1 2 3 4 5 with a space between each value and no newline.

When little is 17 and big is 20, the pattern is 20 19 18 17 18 19 20

a. Write an iterative version of the function using a loop(s). Think simple and straightforward. This is not a trick.

```java
public static void pattern(int little, int big) {
    for (int i = big; i >= little; i--)
        System.out.print(i + " ");
    for (int j = little + 1; j <= big; j++)
        System.out.print(j + " ");
}
```

b. Write a recursive version of the same function. It should use NO (absolutely no) loops. What is the base case?

```java
public static void pattern(int little, int big) {
    if (little > big)
        return;
    else if (little == big) {
        System.out.print(little + " ");
        return;
    }
    else {
        System.out.print(big + " ");
        pattern(little, big-1);
        System.out.print(big + " ");
    }
}
```

(1) What is the output of the following code if it is called with mystery(4)?

```java
public static void mystery(int n) {
    if (n > 0) {
        System.out.print(n + " ");
        mystery(n-3);
        mystery(n-2);
        System.out.print(n + " ");
    }
}
```

4 1 1 2 2 4
For the binary tree below neatly write your answers to the following:

```
42
/ \ 
17 58
/ \  
12 29 72
/ \ 
68 99
```

a. Is it a binary search tree? Why or why not?
   Yes, at each node all values to left are <= node value, all values to right are >

b. Show the result of an inorder traversal of this tree as shown.
   12 17 29 42 58 68 72 99

c. Show the result of an preorder traversal of this tree as shown.
   42 17 12 29 58 72 68 99

d. Show the result of a postorder traversal of this tree as shown.
   12 29 17 68 99 72 58 42

e. Write the recursive code for doing a preorder traversal of a binary tree that stores characters. You can assume that you are given the root node as node, as shown below:

   ```java
   public  void printPreorder(CharBTNode node) {
     if (node == null)
       return;
     else {
       System.out.print(node.getData() + " ");
       printPreOrder(node.getLeft());
       printPreOrder(node.getRight());
     }
   }
   ```

f. The text suggests that a binary search tree would be a more efficient way to represent a Bag than the various ways we studied in class especially when searching. Why?
   Because the organization of a binary search tree allows you to focus the search, ruling out portions of the data with each step rather than examining each element until you find the target.