TIME STARTED: _____
TIME ENDED: _____

CSE 143 SUMMER 2005
MIDTERM EXAMINATION

NAME: **KEY**
TA:

0. (4 points) Write your name and TA's name above and read and sign the box below.

0		**6**	
1		**7**	
2		**8**	
3		**9**	
4		**10**	
5		**11**	
TOTAL			

READ AND SIGN THIS:

I certify that the answers on this exam are all my own work, and that I have not discussed the exam questions or answers with anyone in the class who has already taken the exam. I also will not (directly or indirectly) discuss the exam questions or answers with anyone in the class who has not yet taken the exam.

_____

1. (5 points) In some methods, you wrote code to check if a certain precondition was held. If the precondition did not hold, then you threw an exception. This leads to robust code by catching client code misusing your methods. This seems like a great idea, so when would you **NOT** want to check for the precondition in a method? Why wouldn't you? (You may use no more than 30 words.)

   Answers (or close derivatives thereof) we accepted:
   - It would be too inefficient to do so.
   - The precondition is ensured by the other methods in the class.

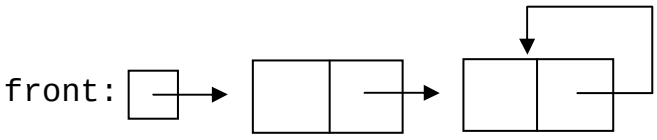
2. (5 points) Recall the definition of the `ListNode` class:

```
public class ListNode {
     int data;
     ListNode next;
}
```

   We can print a linked list using the following method:

```
public static void print(ListNode front) {
     ListNode current = front;
     while (current != null) {
          System.out.println(current.data + " ");
          current = current.next;
          if (current == front) {
               break;
          }
     }
}
```

   Starting from the node pointed to by `front`, draw one or more nodes and link them together in such a way that the call `print(front)` will **not** "behave" properly.



3. (8 points) Consider the following method:

```
public void mystery(int n) {
     if (n >= 7) {
          System.out.println(n);
     } else {
          System.out.print(n);
          System.out.print(n);
          mystery(n + 7);
     }
}
```

For each call below, indicate what output is produced by the method. If the call results in infinite recursion, write out the first 5 characters followed by "…".

Method Call	Output Produced
`mystery(-1)`	-1-16613
`mystery(711)`	711
`mystery(0)`	007
`mystery(-5)`	-5-5229

4. (8 points) Consider the following method:

```
public void mystery(int n) {
     if (n == 0) {
          System.out.print(n);
     } else {
          System.out.print("(");
          mystery(n – 1);
          System.out.print(n);
          mystery(n – 1);
          System.out.print(")");
     }
}
```

For each call below, indicate what output is produced by the method. If the call results in infinite recursion, write out the first 5 characters followed by "…".

Method Call	Output Produced
`mystery(2)`	((010)2(010))
`mystery(0)`	0
`mystery(-1)`	(((((…
`mystery(1)`	(010)

5. (20 points) A palindrome reads the same backward or forward. The number 12321 is a palindrome, because if you start from the left side or the right side, it reads exactly the same way. Write a method `isPalindrome` that takes an integer array `nums` and returns `true` or `false` if the array of numbers constitute a palindrome in the sense that the first element matches the last element; the second element matches the second-to-last element, and so on. Do **NOT** use recursion.

Examples where `isPalindrome` would return `true`:

123	2	24	2	123

123	2	214	99	99	214	2	123

Examples where `isPalindrome` would return `false`:

123	2	24	1	123

123	2	214	99	98	214	2	125

```
public boolean isPalindrome(int[] nums) {
     for (int i = 0; i < nums.length; i++) {
          if (nums[i] != nums[nums.length - 1 – i]) {
               return false;
          }
     }
     return true;
}
```

If your solution to this problem is blank, you will receive ¼ credit (5 points).

6. (10 points) What is the running time of this method? Circle one: (O(1)) O(n)

```
public int add100(int[] array) {
     if (array.length < 100) {
          return 0;
     }

     int sum = 0;
     for (int i = 0; i < 100; i++) {
          sum += array[i];
     }
     return sum;
}
```

Explain your answer in 30 words or less.

We are interested in the running time as the array gets larger and larger. After the array exceeds a size of 100, the size of the array is irrelevant, and a constant number of steps is needed to solve the problem.

7. (20 points) Recall the definition of the `ListNode`:

```
public class ListNode {
     int data;
     ListNode next;
}
```

Assume that we define a class `SortedLinkedIntList` that is similar to `LinkedIntList`, except that the data stored in the nodes are in sorted order:

```
public class SortedLinkedIntList {
     private ListNode front;

     <methods>
}
```

Write a method `mode(void)` for the `SortedLinkedIntList` class that returns the mode of the numbers in the list. The mode of a set of a numbers is the number that appears the most frequently. If there is a tie, return any of the numbers that share the highest frequency. If the list is empty, throw an `IllegalStateException`.

For example, if the list contained [1,1,1,4,4,4,4,4,4,5,6,6,70,99,99], then a call to `mode()` would return `4`, since it appears the most frequently (six times). If the list contained [1,4,4,7,7,11,25,25,99], then your method can return either `4`, `7`, or `25`, because they all share the highest frequency (two times).

Answer on next page.

If your solution to this problem is blank, you will receive ¼ credit (5 points).

```
public int mode(void) {
     if (front == null) {
          throw new IllegalStateException();
     }

     int value = front.data;
     int maxRun = 1;
     int currentRun = 1;

     ListNode current = front.next;
     ListNode last = front;
     while (current != null) {
          if (current.data == last.data) {
               currentRun++;
               if (currentRun > maxRun) {
                    maxRun = currentRun;
                    value = current.data;
               } else {
                    currentRun = 1;
               }
          }
          last = current;
          current = current.next;
     }
     return value;
}
```

Stack Interface

```
// Interface Stack defines a set of operations for manipulating a
// LIFO (Last In First Out) structure that can be used to store
// objects.

public interface Stack {
    // post: given value is pushed onto the top of the stack
    public void push(Object value);

    // pre : !isEmpty()
    // post: removes and returns the value at the top of the stack
    public Object pop();

    // post: returns true if the stack is empty, false otherwise
    public boolean isEmpty();

    // post: returns the current number of element in the stack
    public int size();
}
```

Queue Interface

```
// Interface Queue defines a set of operations for manipulating a
// FIFO (First In First Out) structure that can be used to store
// objects.

public interface Queue {
    // post: given value inserted at the end of the queue
    public void enqueue(Object value);

    // pre : !isEmpty()
    // post: removes and returns the value at the front of the queue
    public Object dequeue();

    // post: returns true if the queue is empty, false otherwise
    public boolean isEmpty();

    // post: returns the current number of element in the queue
    public int size();
}
```

8. (30 points) Write a method `pushNumTimes` that takes a `Queue q` as an argument and returns a `Stack`. Assume that `q` is storing `Integer` objects. Each integer value `i` at position `n` (where the object at the front of the queue has position `1`) in the queue will be replaced by an `Integer` object with an integer value of `(i * n)` on the stack. The contents of the queue do **not** have to be preserved.

For illustration purposes, let a queue's contents be represented as a list of numbers, where the leftmost number represents the front of the queue; let a stack's contents be represented as a list of numbers where the leftmost number represents the top of the stack. Suppose `q` initially contained [6, 4, 5, 3], then the stack returned from a call to `pushNumTimes(q)` will have [6, 8, 15, 12].

For your convenience, the `Queue` and `Stack` interfaces are on the previous page. The names of the classes that implement those interfaces are `LinkedQueue` and `ArrayStack`, respectively. Both classes have constructors that take no arguments.

If `q` initially contained:

6	4	5	3
1	2	3	4

position:

Then the returned stack would contain:

6
8
15
12

```
public Stack pushNumTimes(Queue q) {
      Stack s = new ArrayStack();
      int counter = 1;
      while (!queue.isEmpty()) {
            int n = ((Integer)queue.dequeue()).intValue();
            s.push(new Integer(n * counter));
            counter++;
      }
      while (!s.isEmpty()) {
            q.enqueue(s.pop());
      }
      while (!q.isEmpty()) {
            s.push(q.dequeue());
      }
      return s;
}
```

9. (20 points) Consider the following definitions:

```
public class Apple extends Date {
     public void method2() {
          System.out.println(“Apple2”);
     }
}

public class Banana {
     public void method2() {
          System.out.println(“Banana2”);
     }
}

public class Cherry extends Date {
     public void method2() {
          System.out.println(“Cherry2”);
     }

     public void method1() {
          super.method1();
          System.out.println(“Cherry1”);
     }
}

public class Date extends Banana {
     public void method1() {
          System.out.println(“Date1”);
     }

     public void method2() {
          System.out.println(“Date2”);
          method1();
     }
}
```

And assuming the following variables have been defined:

```
Object var1 = new Cherry();
Banana var2 = new Date();
Banana var3 = new Cherry();
Apple var4 = new Apple();
```

In the table below, indicate in the right-hand column the output produced by the statement in the left-hand column. If the statement produces more than one line of output, indicate the line breaks with slashes as in "`a/b/c`" to indicate three lines of output with "`a`" followed by "`b`" followed by "`c`". If the statement causes an error, fill in the right-hand column with either the phrase "compiler error" or "runtime error" to indicate when the error would be detected.

Statement	Output
`var1.method1();`	compiler error
`var2.method1();`	compiler error
`var3.method1();`	compiler error
`var4.method1();`	Date1
`((Cherry)var2).method1();`	runtime error
`((Date)var2).method2();`	Date2 / Date1
`((Date)var1).method2();`	Cherry2
`((Cherry)var1).method1();`	Date1 / Cherry1
`((Cherry)var4).method1();`	compiler error
`((Date)var3).method2();`	Cherry2

10. (20 points) **Using recursion**, write a method `times` that takes two integers `a` and `b` as parameters and returns their product, *i.e.*, `a * b`. You are to multiply them by using a series of additions. You may use `+`, `-`, comparison operators (`>`, `>=`, `<`, `<=`, `==`, `!=`), and Boolean operators (`&&`, `||`). You may NOT use `*`, `/`, any loops (*i.e.*, `for` or `while`) or any method from the Java library.

You may find the following equality useful: `a * b = b + (a – 1) * b`

For at most ¾ credit (*i.e.*, 15 points), you may assume that both arguments are non-negative. If you would like that option, sign here: _____

```
public int times(int a, int b) {
        if (a < 0) {
             return –times(-a, b);
        }
        if (a == 0) {
             return 0;
        }
        return b + times(a-1, b);
}
```

If your solution to this problem is blank, you will receive ¼ credit (5 points).

11. (BONUS: 5 points) Tell us a funny story or joke. If your submission cracks everyone on the course staff up, you'll get an extra smiley face. If you're not a funny person, you may draw your TA. If it looks like you spent more than a minute, you get full-credit.

If you didn't leave this page blank, we gave you 5 extra points.