1. (15 points) For the following sequence of lines of Java code, label the lines where a cast is needed, and whether it will be automatic (implicit) or must be forced (explicit):

```java
int i = 5;
double d = i;
char c = i;
double d2 = c;
int i2 = c + 3;
char c2 = c + '3';
```

2. (15 points) What output will the following program generate?

```java
class ArrayStuff {
    private static void doStuff (int[] x) {
        x[1] = 22;
        x = new int[6];
        x[2] = -20;
    }

    public static void main (String[] args) {
        int[] x = new int[4];
        x[2] = -15;
        doStuff(x);
        for (int index = 0; index < x.length; index++) {
            System.out.println("x[" + index + "] = " + x[index]);
        }
    }
}
```
3. (15 points) What output will the following program generate?

```java
class Fib {
    private static int fib (int n) {
        if ((n == 0) || (n == 1)) {
            System.out.println("Base case " + n);
            return 1;
        } else {
            System.out.println("Beginning " + n);
            int i = fib(n - 1);
            System.out.println("Middle " + n);
            int j = fib(n - 2);
            System.out.println("End " + n);
            return i + j;
        }
    }
    public static void main (String[] args) {
        fib(4);
    }
}
```
4. (15 points) Consider the following definitions of the classes Foo and Bar:

```java
class Foo {
    protected int _x;
    public void yahoo(int i) {
        _x = i * 13 + 2;
    }
}
class Bar extends Foo {
    public void geronimo() {
        _x = _x / 2;
    }
}
```

Now consider the following methods that are not part of Foo or Bar, but that use objects of those types:

```java
public static void fleeble(Foo p, Foo q) {
    p.yahoo(5);
    q.yahoo(6);
    Bar b = (Bar)q;
    b.geronimo();
    b = (Bar)p;
    b.geronimo();
}

public static void yadda() {
    Foo f = new Foo();
    Bar b = new Bar();
    fleeble(f, b);
}
```

**The question:** This code will either not compile or not run. Where is the error? How will it manifest itself? Why is it an error?
5. (20 points) Write a class named **Shape** that can serve as the parent class for subclasses whose objects will represent different geometric shapes. (That is, it should be possible to create a **Rectangle** subclass, a **Ellipse** subclass, etc.) Define the **Shape** class to have the following characteristics:

- Each **Shape** object stores its position as a pair of real-valued Cartesian coordinates that indicate the shape's center.
- The coordinates of the center of a **Shape** object can be obtained by calling its `getX()` and `getY()` methods.
- A **Shape** object is immutable.
- Each **Shape** object contains a method named `getArea()` which returns the area contained by that shape.
- The class contains a `getNumberOfPoints()` method that returns the number of **Shape** objects that have been created so far.

6. (20 points) Consider the following arrays of **char**:

   (a) Hello there!
   (b) ello
   (c) foo
   (d) Hll

We say that (b) is contained by (a)—that is, (b) is a subsequence of (a). We can also say that (c) is not contained by (a), since those characters don’t appear in that order within (a). Finally, we can say that even (d) is not contained by (a); although those letters do appear in that order in the character array, they do not appear contiguously.

Write a method named `contains` that determines whether or not one character array contains another. Specifically, this method should accept two pointers to characters arrays from the caller. If the first character array contains of the second, then this method should return `true`; otherwise, it should return `false`. Be sure that your code is robust—that is, it should not crash at run time, no matter what arguments are passed.