Question 3. (15 points) Given the class definitions shown in the box below, which of the following statements are legitimate in Java and why?

```
interface ShapeInfo {
    public double area();
} // end interface ShapeCharacteristics

class Shape {
    protected int x;
    protected int y;

    public Shape(int inX, int inY) {
        x = inX;
        y = inY;
    }

    public String describe () {
        return "unknown shape";
    }

    public boolean equals (Object arg) {
        if (arg instanceof Shape) {
            Shape argS = (Shape) arg;
            if (x == argS.x && y == argS.y)
                return true;
        } // end if
        return false;
    }
} // end class Shape

class Square extends Shape implements ShapeInfo {
    protected int side;

    public Square(int inX, int inY, int inSide) {
        super(inX, inY);
        side = inSide;
    }

    public String describe () {
        return "square with side " + side;
    }

    public double area() {
        return (double) side * side;
    }
} // end class Square

class Circle extends Shape implements ShapeInfo {
    protected int radius;

    public Circle (int inX, int inY, int inRadius) {
        super(inX, inY);
        radius = inRadius;
    }

    public double area() {
        return (double) Math.PI * radius * radius;
    }
} // end class Circle
```

a) Shape s = new Square(6, 8, 3);
b) Circle c = new Square(10, 12, 4);
c) Square s = new Shape(9, 5);
d) Shape s = new Circle(8, 10);
e) ShapeInfo i = new Square(3, 4, 5);

Question 4. (10 points) What would be printed by the following code?

```
Square s = new Square( 2, 3, 4 );
Square sqr = new Square( 4, 5, 6 );
System.out.println( s.describe() + " and " + sqr.describe() );

s = sqr;
System.out.println( s.describe() + " and " + sqr.describe() );

Circle c = new Circle( 1, 2, 3 );
System.out.println( c.describe() );
```
Question 5. (10 points) Consider the `equals` method of the `Shape` class in question 4.

a) Why is an `equals` method even necessary for comparing two `Shape` objects?

b) Write an `equals` method for the `Circle` class. We want two circles to be equal if they have the same values of x, y, and radius.