Problem E: Shapes with Polymorphism

(30% related to Lab 10)

Problem Description

Based on the base class Shape below, design three derived shape classes Triangle, Rectangle, and Circle.

```
class Shape
{
public:
    Shape() { };
    virtual double area() const = 0;
    virtual bool inside(const Pt &) const = 0 ;
    virtual double perimeter() const = 0;
    virtual bool degenerate() const = 0;
    virtual void print() const =0;
};
```

area() calculates the area of a shape.
Inside(const Pt& pt) checks whether a point pt is inside a shape.
perimeter() calculates the perimeter of a shape.
degenerate() checks whether a shape is degenerated. For example, a circle becomes a point; a rectangle becomes a line; a triangle becomes a line, etc.
print() should print shape type, coordinates of a shape, radius for a circle, area, and perimeter of a shape. Then, check whether a shape is degenerated. If yes, print “This shape is degenerated.”

Also given the class definition **Pt** for point as follows, you should implement the member functions not provided here. You may optionally implement a class for line.

```
class Pt{
public:
    Pt(double = 0, double =0);
    bool operator==(const Pt&) const; // check two points being equal
    bool operator!=(const Pt&) const; // check two points being no equal
    double getX() const {return x; };
    double getY() const {return y;};
    void print() const {cout << "(" << x << ", " << y << ") ";};
private:
    double x;
    double y;
};
```

You should also implement a function **string shapeType(Shape *)** to return the kind of shape specified by the parameter. If the given shape is a rectangle, then return a message “# The given shape is a rectangle.” If it is a triangle, then return a message “# The given shape is a triangle.” If it is a circle, then return a message “# The given shape is a circle.”

Input format

The input to the program will be the data stored in some arrays. Provide the required number of integers based on the prompting message.

Output format

The output should be exactly same as the printout given in the example output.

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Requirements

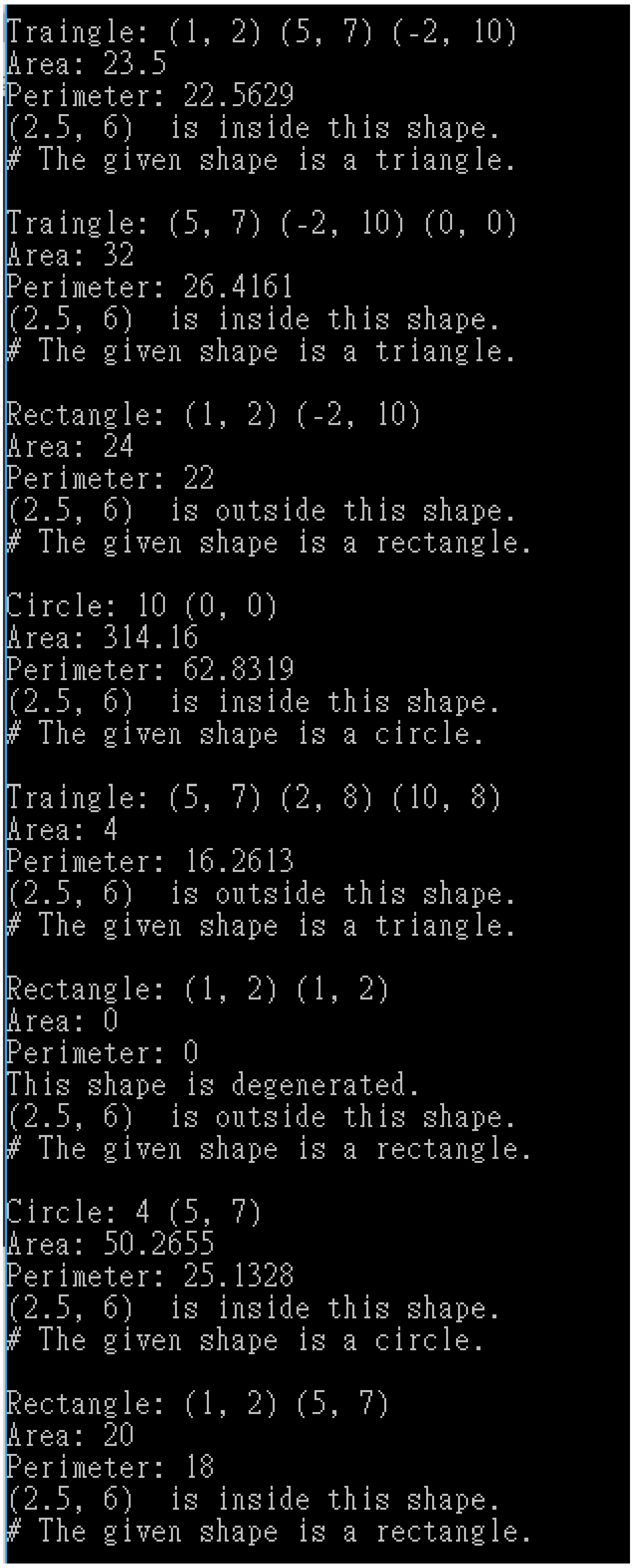
The main() function is given to you below. There is a small mistake in one line of the main() function, which causes compilation failure. You should correct the mistake.

```
int main()
{
    Pt p1(1, 2); // a point defined by X and Y coordinates
    Pt p2(5, 7);
    Pt p3(-2, 10);
    Pt p4(0, 0);
    Pt p5(2.5, 6);
    Pt p6(2, 8);
    Pt p7(10, 8);
    Triangle tr1(p1, p2, p3);   // defined by giving three points
    Triangle tr2(p2, p3, p4);
    Triangle tr3(p2, p6, p7);
    Rectangle rect1(p1, p3); // defined by lower left and upper right points
    Rectangle rect2(p1, p1);
    Circle cir1(p4, 10.0);   // defined by a center point and its radius
    Circle cir2(p2, 4);
    Rectangle rect3(p1, p2);
    const int numShape = 8;
    vector < Shape > baseShape(numShape);
    baseShape[0] = &tr1;
    baseShape[1] = &tr2;
    baseShape[2] = &rect1;
    baseShape[3] = &cir1;
    baseShape[4] = &tr3;
    baseShape[5] = &rect2;
    baseShape[6] = &cir2;
    baseShape[7] = &rect3;
    for(int i=0; i<numShape; i++){
        baseShape[i]->print();
        p5.print();
          if(baseShape[i]->inside(p5))
            cout << " is inside this shape." << endl;
        else
            cout << " is outside this shape." << endl;
        cout << shapeType(baseShape[i])<< endl;
    }
    return 0;
}
```

Example Input:

No input.

Example Output (containing input):



```
Traingle: (1, 2) (5, 7) (-2, 10)
Area: 23.5
Perimeter: 22.5629
(2.5, 6)  is inside this shape.
# The given shape is a triangle.

Traingle: (5, 7) (-2, 10) (0, 0)
Area: 32
Perimeter: 26.4161
(2.5, 6)  is inside this shape.
# The given shape is a triangle.

Rectangle: (1, 2) (-2, 10)
Area: 24
Perimeter: 22
(2.5, 6)  is outside this shape.
# The given shape is a rectangle.

Circle: 10 (0, 0)
Area: 314.16
Perimeter: 62.8319
(2.5, 6)  is inside this shape.
# The given shape is a circle.

Traingle: (5, 7) (2, 8) (10, 8)
Area: 4
Perimeter: 16.2613
(2.5, 6)  is outside this shape.
# The given shape is a triangle.

Rectangle: (1, 2) (1, 2)
Area: 0
Perimeter: 0
This shape is degenerated.
(2.5, 6)  is outside this shape.
# The given shape is a rectangle.

Circle: 4 (5, 7)
Area: 50.2655
Perimeter: 25.1328
(2.5, 6)  is inside this shape.
# The given shape is a circle.

Rectangle: (1, 2) (5, 7)
Area: 20
Perimeter: 18
(2.5, 6)  is inside this shape.
# The given shape is a rectangle.
```