Homework #5 – Shape Hierarchy

In this assignment you are asked to implement a hierarchy of classes representing shapes in two and three dimensional space. The following UML class diagram shows the attributes and behaviors of the classes in the shape hierarchy.

Important notes: *UML type Float will map to type* `double` *when implemented in C++. A class name in italics indicates that the class is abstract. A member function name in italics indicates that the function is pure virtual.*

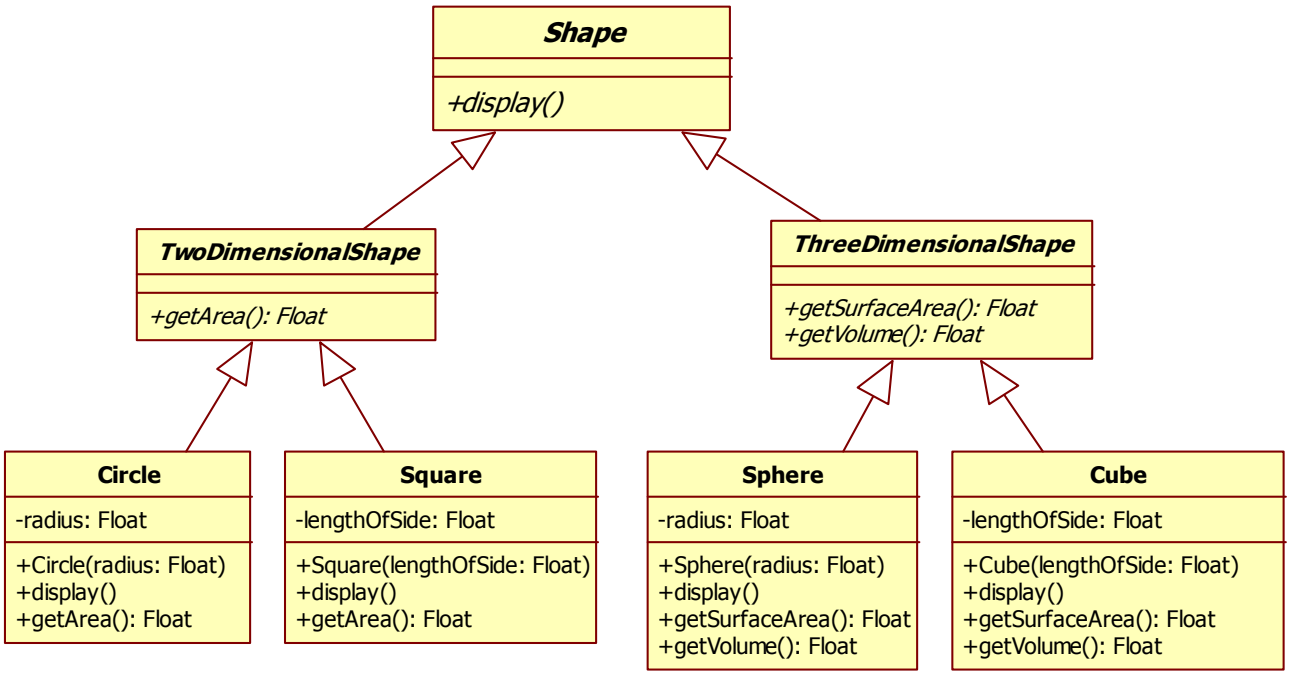

Figure 1. UML class diagram for Shape hierarchy

1. **(1 point)** Meet these basic requirements:
   a. All classes must be implemented in a namespace based on your first and last name (e.g. "RayMitchell").
   b. All class definitions must all be placed in a file named "Shapes.h".
   c. All member function implementations must all be placed in a file named "Shapes.cpp".
   d. Member functions must be marked as `const` where appropriate.

2. **(1 point)** Implement class `Shape` as shown in the UML diagram.

3. **(1 point)** Implement class `TwoDimensionalShape` as shown in the UML diagram.

4. **(1 point)** Implement class `ThreeDimensionalShape` as shown in the UML diagram.

5. **(1 point)** Implement class `Circle` as shown in the UML diagram. Function display should output the `Circle`'s radius and area in the following format:

```
Circle with radius 2 has area 12.5664
```

6. **(1 point)** Implement class `Square` as shown in the UML diagram. Function display should output the `Square`'s length of side and area in the following format:

```
Square with length of side 3 has area 9
```

7. **(1 point)** Implement class `Sphere` as shown in the UML diagram. Function display should output the `Sphere`'s radius, surface area, and volume in the following format:

```
Sphere with radius 4 has surface area 201.062 and volume 268.083
```

8. **(1 point)** Implement class `Cube` as shown in the UML diagram. Function display should output the `Cube`'s length of side, surface area, and volume in the following format:

```
Cube with length of side 5 has surface area 150 and volume 125
```

9. **(1 point)** Implement a test program in a file named "hw5.cpp". Your test program should do the following:
    a. Define an array of four pointers to `Shape`s.
    b. Use the `new` operator to create a `Circle`, `Square`, `Sphere`, and `Cube`. Store pointers to these objects in the array of pointers to `Shape`s.
    c. Loop over the array of pointers to `Shape`s. Each time through the loop call the `display` function on the current `Shape` then destroy the `Shape` using the `delete` operator.

10. **(1 point)** Make sure your source code is well-commented, consistently formatted, uses no magic numbers/values, follows a consistent style, and is ANSI-compliant.

Place all source code and a screen capture of the output produced by your program in a single Word or PDF document. Submit this document.