AP Computer Science A (Java)
Classes, Interfaces and Abstract Classes Programming Project

Complete the following project:

1. Develop a project named Shapes3D with an inheritance hierarchy of three-dimensional shapes.
    a. Create a top-level shape interface named Shape3D that has methods for getting the volume and surface area of a three-dimensional shape. The volume method should be named getVolume() and return a double. The surface area method should be named getSurfaceArea() and return a double.
    b. Create classes and subclasses that implement the following 4 shapes: cube, rectangular prisms, square pyramid and sphere.
        i. Place common behavior in superclasses whenever possible.
        ii. One of these shapes can be a subclass of another shape. Which one? Implement it as a subclass of the other class.
        iii. Consider the fields needed for each class. Add methods to the classes to represent the unique behavior of each three-dimensional shape, such as a method to get a sphere's radius.
    c. Using the abstract classes named CircularShape and CircularShapeWithHeight, create a class for cone and another class for cylinder. These classes extend the CircularShapeWithHeight class. The purpose of the abstract classes is to eliminate repetitive code that would otherwise occur in cone and cylinder class. Therefore, be sure to use the methods from CircularShape and CircularShapeWithHeight when writing your getSurfaceArea and getVolume methods.
    d. Include accessor methods for each instance variable.
    e. Include toString methods which print the type of 3D object and each instance variable name followed by its value.
    f. Include equals methods which compare instance variables and return true if all instance variables are the same values.
    g. Include a class comment for the cube, rectangular prism, square pyramid, sphere, circular cone and cylinder class.

Formulas: (Note: crossSectionArea = pi * r * r and crossSectionPerimeter = 2 * pi * r)

Shape	**Volume**	**Surface Area**
cube	size * size * size	2 * (size * size + size * size + size * size) = 6 * size * size
rectangular prism	length * width * height	2 * (length * width + width * height + length * height
square pyramid	length * length * height / 3.	length * (length + square root of (length * length + 4 * height * height))
sphere	4. * pi * r * r * r / 3	4. * pi * r * r
circular cone	crossSectionArea * height / 3.	pi * r * (square root of (r * r + h * h)) + crossSectionArea
cylinder	crossSectionArea * height	crossSectionPerimeter * height + 2 * crossSectionArea

A suggestion is to get one class working at a time. To test a shape, create a Main class that tests that particular class.

The output from running Shape3DMain should be:

Shape 0:
Array 1 shape is a Cube with length, width and height of 7.0
Volume is: 343.0
Surface Area is: 294.0
Array 2 shape is a Cube with length, width and height of 5.0
Does this shape = the shape in the second array? false
Shape 1:
Array 1 shape is a Rectangular Prism with length of 2.0, width of 3.0 and height of 4.0
Volume is: 24.0
Surface Area is: 52.0
Array 2 shape is a Rectangular Prism with length of 2.0, width of 3.0 and height of 4.0
Does this shape = the shape in the second array? true
Shape 2:
Array 1 shape is a Square pyramid with base length of 4.0 and height of 5.0
Volume is: 26.666666666666668
Surface Area is: 59.08131845707603
Array 2 shape is a Square pyramid with base length of 5.0 and height of 5.0
Does this shape = the shape in the second array? false
Shape 3:
Array 1 shape is a Sphere with radius 3.0
Volume is: 113.09733552923255
Surface Area is: 113.09733552923255
Array 2 shape is a Sphere with radius 3.0
Does this shape = the shape in the second array? true
Shape 4:
Array 1 shape is a Circular Cone with radius of 4.0 and height of 7.0
Volume is: 117.28612573401894
Surface Area is: 151.57880131104514
Array 2 shape is a Circular Cone with radius of 4.0 and height of 8.0
Does this shape = the shape in the second array? false
Shape 5:
Array 1 shape is a Cylinder with radius of 3.0 and height of 5.0
Volume is: 141.3716694115407
Surface Area is: 150.79644737231007
Array 2 shape is a Cylinder with radius of 3.0 and height of 5.0
Does this shape = the shape in the second array? true

Does a sphere = a cube? false

Does a circular cone = a cylinder? false

Does a cube = a rectangular prism? true

Does a rectangular prism = a cube? true