**ARCHIMEDES’ PRINCIPLE AND BUOYANCY**

Josiah Abel, Logan Hoover, and Dathan Havins

November 5th, 2014

**OBJECTIVE:** To determine the density of a solid cylinder using Archimedes’ Principle and to identify the material from which the object is constructed using its density.

**THEORY:** when an object is placed in water, the volume of the object displaces an amount of water. Also within this interaction is the force of buoyancy or the upwards pressure of water on an object that is either fully or partially immersed. This force is equal in magnitude to the weight of the liquid displaced by the object.

**PROCEDURE:**

Part 1

Two substances of unknown mass and material were weighed on a scale (Mair). Next they were weighed under water (Mwater). Both masses for each object were recorded. The density of water was recorded as 1000 kg/m3 (water). The density of each of the objects was calculated using Archimedes’ Principle. The density of gold and silver were compared to the substances. The density of brass and aluminum were compared to object 1 and object 2. The percent error was calculated.

Part 2

Next the objects were each placed separately into a marked graduated cylinder with water and the change in volume was recorded. Density was calculated using the equation mass divided by volume. The calculated density for each was compared to the expected densities of brass and aluminum. Percent error was calculated again for each object.

Part 3

Each object had its circumference and height measured and recorded. After dividing the circumference in half to get the radius the volume of each cylinder was calculated using the equation of the volume of a cylinder. Density was then mathematically calculated again using this new volume. The density of object 1 was compared to the density of brass and the density of object 2 was compared to aluminum. Percent error was once again calculated.

**DATA:**

Mass of object #1 in the air: 0.2075 kg

Mass of object #1 in the water: 0.1779 kg

Mass of object #2 in the air: 0.0668 kg

Mass of object #2 in the water: 0.0378 kg

Density of Gold: 19.3 x 103 kg/m3

Density of silver: 10.5 x 103 kg/m3

Density of Brass: 8.725 x 103 kg/m3

Density of Aluminum: 2.7 x 103 kg/m3

Archimedes’ Principle: Part 1

object = (Mair x water)/ (Mair - Mwater)

Sample Calculations:

Object #1 (not gold)

(0.2075 kg x kg/m3)/ (0.2075 kg – 0.1779 kg) = 7.01 x 103 kg/m3

Object #2 (not silver)

(0.0668 kg x kg/m3)/ (0.0668 kg – 0.0378 kg) = 2.3 x 103 kg/m3

Volume Displacement: Part 2

object = Mair/Vdisplaced

Vdisplaced = 2.45 x 10-5 m3

Note: the volume of water displaced by both objects was the same.

Sample Calculations:

Object #1 (not Gold)

0.2075 kg / 2.45 x 10-5 m3 = 8.469 x 103 kg/m3

Object #2 (not Silver)

0.0668 kg / 2.45 x 10-5 m3 = 2.727 x 103 kg/m3

Mathematical Volume: Part 3

object = Mair/Vcylinder

Vcylinder = (r2) x h

Diameter / 2 = r

Sample Calculations:

Object #1 (not gold)

Diameter = 0.022 m, height = 0.063 m, r = 0.011 m

0.2075 kg / (0.011 m)2( 0.063 m)) = 8.664 x 103 kg/m3

Object #2 (not silver)

Diameter = 0.022 m, height = 0.063 m, r = 0.011 m

0.0668 kg / (0.011 m)2( 0.063 m)) = 2.789 x 103 kg/m3

Percent Error:

Accepted value for object 1 = 8.725 x 103 kg/m3 (density of brass)

Accepted value for object 2 = 2.7 x 103 kg/m3(density of aluminum)

Sample Calculation:

(Accepted – Experimental)/Accepted x 100 = % error

**RESULTS:**

Part 1

Density of object 1 = 7.01 x 103 kg/m3

% error = 19.7 %

Object 1 is most likely made of brass

Density of object 2 = 2.3 x 103 kg/m3

% error = 14.8 %

Object 2 is most likely made from aluminum

Part 2

Density of object 1 = 8.469 x 103 kg/m3

% error = 2.93 %

Density of object 2 = 2.727 x 103 kg/m3

% error = 1.00 %

Part 3

Density of object 1 = 8.664 x 103 kg/m3

% error = 0.70 %

Density of object 2 = 2.789 x 103 kg/m3

% error = 3.30 %

**ERROR ANALYSIS:** In part 1 of the experiment the object could have been touching the sides of the graduated cylinder as it was weighed this could result in an inaccurate scale reading. Also the position of the object on the scale arm could have modified the reading of the scale. In part 2 of the experiment the amount of water displaced could have been misinterpreted or measured from the wrong point on the meniscus.

**CONCLUSION:** By comparing the calculated densities of the object 1 to the densities of brass and gold it can be determined that object 1 is made of brass because its density is closest to the accepted density of brass. Object 2 is made of aluminum not silver because its measured density is closer to the accepted density of aluminum. The most accurate density calculations were performed in part two of the experiment.