Name: _____ ID No.:_____ Date: _____

Section: _____ Score: _____

Preparatory Physical Science (PHSC001)
Experiment No. 1
Measurement of Length, Mass, and Density

Key Terms:

Measurement Length Volume Mass Liter Density

Experiment objectives:

To measure the length, mass, and volume of some metallic objects and then to determine the density of solid and liquid objects.

Theory:

Measurement is a process of comparing a property of an object like length to a well defined and agreed upon standard unit. ***Length*** is a fundamental or the simpler property of an object. Area, the extent of a surface, is not fundamental property because it is described as a combination of two measured lengths. Volume, or the space that an object occupies, is a property that is described by a combination of three length measuremts as shown in Figure 1.1.

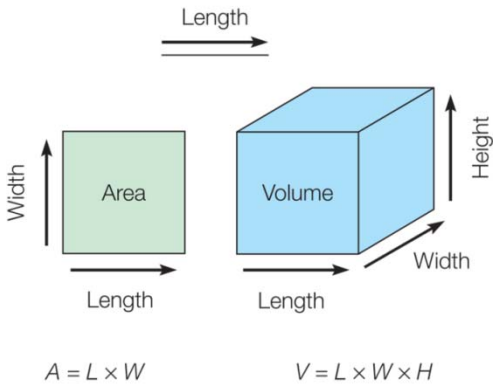

Figure 1.1 Length, area, and volume properties of an object.

We will use the metric system of measurements. The S.I of length in the metric system is the meter (symbol m). The meter is equivalent to 100 cm smaller divisions. The volume (symbol V) is measured in cubic meter ($1m^3=10^6$ cm^3). The common unit used to measure liquid volume in the metric system is the liter (symbol L); for smaller amount of liquid volume, the milliliter (symbol ml) is used. 1ml is the same volume as $1cm^3$ ($1ml = 1$ cm^3).

Mass is the amount of matter an object has. Mass and weight are completely different properties and are measured by different units. Mass is measured in Kilogram (symbol kg) and weight is measured in Newton (symbol N). Small quantities are measured in gram (symbol g) or fractions of gram or milligram (symbol mg); 1 kilogram equals 10^3 g and 1g equals 10 mg.

Density is the ratio of mass to volume ***(symbol ρ or D)*** or

$$Density = \frac{Mass}{volume}, \ in \ \ symb$$

$$\rho = \frac{m}{V}$$

Density is measured in units of ***kilogram per cubic meter (kg/m^3)*** or ***gram per cubic centimeters or (g/cm^3)***. The "per" means "for each".

Materials and equipments:

- Three different in shape solid metallic objects (parallelepiped and cylinders)
- Ruler
- Thread
- 250 mL beaker
- Laboratory pan balance

Experiment

Part A: Measurement of length

1. From the prep station, obtain three different blocks and a ruler

2. Measure the length, width, and height of each block or height and diameter of a cylinder. Do not return these objects because you will use them in part B and C

3. Record your results in Table 1

Part B: Measurement of mass

1. Make sure that the balance is balanced. A balanced one must show the pointer in the middle (on zero point) of its range. Also, keep the balance pans stationary. A Picture of the balance is shown in Figure 1.2

2. Measure the mass of the three objects you used in part A. Put one object in the pan and then slowly add some weights on the other pan until the pointer moves back to zero position

3. Repeat step 2 for the other two objects

4. Record your results in Table 1

Figure 1.2 The laboratory pan balance

Part C: Volume measurement

1. Fill the beaker to its half capacity with water.

2. Insert a thread through the hole of each object that you used in part A and B. Tight a knot at the end of the thread to secure the object from falling.

3. Hold the other end of thread with your hand and submerge the object completely in water. Do not allow the object to touch the bottom of the beaker

4. Observe the rise in water level in the beaker and measure its new volume.

5. Note that the surface of water is concave. Read the volume at the bottom of the curve.

6. Record your data in Table 2.

7. The rise in the water level represents the volume of the submerged object.

8. Repeat step 4 for the other two objects and record your data in Table 1.

9. Find the density of each object and tabulate your results in Table 1.

Table 1: Measurement of lengths, mass, and density

Object shape	*Mass (g)*	*Length l (cm)*	*Width w (cm)*	*Height h (cm)*	$Volume = l \times w \times h$ (cm^3)	$Density = \frac{mass}{volume}$ (g/cm^3)
Copper (cube)						
Aluminum (cube)						

Table 2: Measurement of volume of cylinders

Object's shape	*Mass (g)*	*Length of cylinder cm*	*Diameter of cylinder cm*	$Radius = \frac{Diameter}{2}$ cm	$Volume = \pi r^2 l$ (cm^3)	$Density = \frac{mass}{volume}$ (g/cm^3)
Copper (cylinder)						
Aluminum (cylinder)						

Table 3: Measurement of volume
(1ml = 1 cm^3)

Object's shape	*Mass (g)*	*Initial water level (a) ml or cm^3*	*Final water level (b) ml or cm^3*	*Object's volume (b-a) ml or cm^3*	$Density = \frac{mass}{volume}$ (g/cm^3)
Copper (cube)					
Aluminum (cube)					
Copper (cylinder)					
Aluminum (cylinder)					

Questions

1. Compare the values of 1 and 2 with the values of table 3. Of the two methods of measuring the volume of different shaped solids, which do you think is the best and why?

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2. Find the density of water in g/cm^3. Design your own procedure and tabulate your results

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3. Depending on your data in question 2 find the mass of one half liter of water.

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4. The property of volume is a measure of

   A. How much matter an object contains
   B. How much space an object occupies
   C. The compactness of matter in a certain size
   D. The area on the outside surface

5. Find the volume of a cube with side length 2cm.

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6. If the density of a pure one gram of liquid water is 1.0 g/cm^3, then the density of three grams of same water will be 3g/cm^3. Justify your answer.

   A. True
   B. False

7. What is the mass of gasoline ($\rho = 0.680 g/cm^3$) in a 94.6 L gasoline tank

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References

1. PHYWE-document series, student experiments in physics, Wolggang Spengler
2. B. Tillery, E. Enger, and F. Ross, "*Integrated Science*"3rd Ed, McGraw Hill 2007

Constant values

Substance	***Density g/cm^3***
Aluminum	**2.70**
Copper	**8.96**
Iron	**7.87**
Lead	**11.4**
Water	**1.00**
Seawater	**1.03**
Mercury	**13.6**