**Measuring the Earth’s Gravity**

**Purpose:** Determine the value of acceleration due to gravity on the earth (***g***) for a falling ball. Using the measured value of ***g***and some information about the size of the Earth to calculate the mass, volume and density of the Earth

**Items:** Digital Stopwatch, Ball, String, tap measure and scale.

**Introduction:** All objects in the universe feel the force of gravity. It is the dominant force in the Universe at large scales. On the surface of the Earth, we feel the pull of gravity all the time. The amount of force we feel is a constant over the entire globe, and this force causes an acceleration which is also constant. This acceleration is the same for all objects at the surface of the Earth regardless of its size or mass and it determines how fast all objects fall.

When you drop the ball its speed increases or it accelerates. You will be trying to find this constant acceleration that is measured in meters per second squared ***(m/s2)***. It is very important that the timing measurements are done very carefully, since a small error can result in a very inaccurate measurement of the acceleration of the Earth’s gravity.

**Procedure:**

**Part I: Determine acceleration due to gravity (*g*) on the surface of the Earth**

1. You instructor will show you a place where you can drop a ball from a height more than 5 meters from ground. Measure and record the distance from the ground to the dropping point using tape measure. Use a piece of string to measure the height if the height is more than 10m.

Height = \_\_\_\_\_\_ m

1. You want to drop the ball **at least three times**. Use the stop watch to record the time it takes for the ball to fall to the ground. Be very careful in starting and stopping the stopwatch; small errors in measuring the time of the fall of the ball greatly affect the measurement you are making. Record each value to the nearest hundredth of a second (two decimal places).

Trial 1 = \_\_\_\_\_\_ s; Trial 2 = \_\_\_\_\_\_ s; Trial 3 = \_\_\_\_\_\_ s

1. Calculate and record the average of the three measurement to get the average time it took the ball to fall.

Average time = \_\_\_\_\_\_ s

1. Calculate and record the average speed of the ball during its fall by divide the distance the ball fell from 1) by the average time it took the ball to fall from 3).

Average speed = \_\_\_\_\_\_ m/s

1. The average speed you get in 4) is the average of the initial speed of the ball just before you dropped and the final speed of the ball right before it struck the ground. The initial speed of the ball is zero, calculate and record the final speed of the ball.

Final speed = \_\_\_\_\_\_ m/s

1. Calculate and record the acceleration due to gravity (***g***) by dividing the final speed you get in 5) by the average time you get in 3).

***g*** = \_\_\_\_\_\_ m/s2

1. Compare this calculated value of g in 6) with the accepted value of the acceleration which is 9.8 m/s2. Is your result accurate? Discuss any reasons that might explain an inaccuracy in your results.
2. Measure and record the mass of the ball (**m**) using scale in kg.

**m** = \_\_\_\_\_\_ kg

1. Calculate and record the force of gravity (**F**) by multiplying the mass of the ball (**m**) from 8) by acceleration due to gravity (***g***) from 6)

**F** =**m x *g***= \_\_\_\_\_\_ N

**Part II: Calculate the mass, volume and density of the Earth**

1. Using Newton’s laws listed and the constants given below, calculate the mass of the Earth (**M**) in kg.

**R** is the radius of the Earth, **R**= 6,370,000 m;

**G** is the gravitational constant, **G**= 6.67 x 10-11 m3/kgs2

**m** is the mass of the ball from 8), **F** is the force of gravity from 9)

**M**= \_\_\_\_\_\_ kg

1. Calculate and record the volume of the Earth in m3 using the radius of the Earth (**R**) and the following formula.

= \_\_\_\_\_\_ m3

1. Calculate and record the density (***ρ***) of the earth by dividing the mass of the Earth (**M**) from 10) by the volume of the Earth (**V**) from 11)

***ρ*** = \_\_\_\_\_\_ kg/m3

1. With the list of density of materials provided below, what do you think the Erath is primarily composed of?

A. Water 1000 kg/m3 B. Rock 2500 kg/m3 C. Iron 8000 kg/m3