Lab 6: Measuring g

Purpose

To measure the acceleration due to gravity of two free falling balls by measuring the time they take to fall a distance of 2 meters.

Introduction

Over twenty two centuries ago, the greek philosopher Aristotle proposed that there is a natural force that causes heavy objects to fall toward the center of Earth. He called this force "gravity". In the seventeenth century, the English scientist Isaac Newton was able to show that gravity is a universal force that extends beyond Earth. It is the force that causes the Moon to orbit the Earth and the Earth to orbit the Sun.

When an object is in "free fall", it means that the only force acting on it is the force of gravity. If you ignore air resistance, a falling ball accelerates as if it is in free fall. The constant force of gravity acting on a free falling ball results in a constant acceleration commonly referred to as the acceleration due to gravity, and it is given the symbol ***g***. This value is approximately ***g* = 9.8 m/s²**.

Galileo was the first to measure the rate at which objects of different mass fall to the ground. He found that all objects regardless of their mass accelerate at the same rate as they "free fall" to the ground. On this lab you will repeat Galileo's experiment and measure the acceleration due to gravity of two balls with different mass.

Equations

The equation of motion for a body starting from rest and undergoing constant acceleration can be expressed as

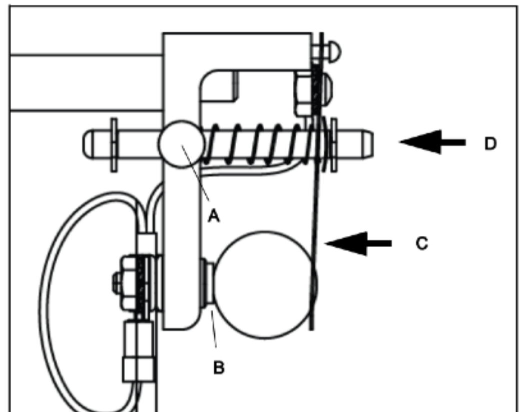
$$d = \frac{at^2}{2}, \qquad \textbf{Eq. 1}$$

where d is the distance traveled, a is the acceleration and t is the time (e.g the free fall time).

- In this lab you will try to find a by measuring d and t, how can you rewrite **Eq.1** so you can use it to find a given d and t?

Setup

The Ball Release Mechanism holds a steel ball between the Release Plate (C) and the Contact Screw (B). The Dowel Pin (D) is pushed into place to hold the Release Plate. A thumbscrew (A) holds the dowel pin in place. A spring on the dowel pin pushes the release plate away from the ball when the thumbscrew is loosened.



Ball Release Mechanism

1. Clamp the ball release mechanism to a support rod.
2. Loosen the thumbscrew slightly. See A.
3. Insert one of the steel balls into the release mechanism between the contact screw and the hole in the release plate. See B. Press the release plate against the ball to hold it in place. See C.
4. Press against the end of the dowel pin so the spring on the dowel pin is compressed and the ball is clamped between the hole in the release plate and the contact screw. See D. Tighten the thumbscrew (A).
5. Position the ball receptor pad directly under the ball and adjust the height of the release mechanism so that the ball is released at exactly 2 meters from the receptor path.
6. Insert the phone plug into the phone jack with the number 1 on the Smart Timer.

Collecting Data

1. Turn on the Smart Timer.
2. Press the Select Measurement button repeatedly until Time is displayed.
3. Press the Select Mode button repeatedly until the Stopwatch mode is displayed.
4. Press the Start/Stop button once. An asterisk will appear on the display indicating that the Smart Timer is ready to collect data.
5. Loosen the thumbscrew on the Free Fall Adapter to release the ball.
6. Read the time on the digital display
7. To prepare for another measurement, put the ball back in the ball release mechanism. Press the Start/Stop button on the Smart Timer.

Data

a. Measure the free fall time of the metallic ball as it falls a distance ***d* = 2 meters**, repeat your measurement 5 times and write your results on the first row of **Table 1**.
b. Do the same for the plastic ball and write your results on the second row of **Table 1**.

Table 1: Free fall times.

Trial	*t1*	*t2*	*t3*	*t4*	*t5*	*t* average
a. Metal Ball						
b. Plastic Ball						

Analysis

3. Using **Eq.1**, solve for the acceleration *a* as a function of *d* and *t.* Then use the average *t* you found for each ball (on **Table 1**) to find the experimental values for the acceleration of each ball.

4. Is the acceleration the same for each ball? Is this what you expected? Why?

5. Compare the acceleration you found experimentally for one of the balls with the theoretically expected gravitational acceleration **g = 9.8 m/s²**. Use the % difference equation for your comparison.

$$\frac{|a-g|}{g} \times 100 =$$