Exercise 4: Vertical Acceleration Due to Gravity

In this exercise, you will explore the motion of falling objects. As an object falls, the velocity of the object will increase due to the acceleration caused by Earth's gravity. A stopwatch will be used to determine the time it takes for a dropped object to fall from a certain height to the floor. From this data, you will calculate the gravitational acceleration.

In this experiment, you will use the equation shown below to calculate the gravitational acceleration.

For an object that starts from rest and then accelerates at a constant rate *g*, the distance *d* it travels after time *t* is expressed as:

$d = \frac{1}{2} gt^2$

Rearranged to solve for *g* as: $\boldsymbol{g = 2d/t^2}$

The value for *g* (gravitation acceleration) is 9.81 m/s^2. However, the value calculated in this experiment may be different due to experimental error. The reaction time of starting and stopping the timer and noting the exact time that the ball has reached the floor will influence the data collected in this exercise.

Procedure

1. Before beginning, set up a data table similar to the Data Table 3.

Data Table 3: Time trials to drop an object 2 m	
Item	Data
Trial 1 Drop time, t, (s)	
Trial 2 Drop time, t, (s)	
Trial 3 Drop time, t, (s)	
Trial 4 Drop time, t, (s)	
Trial 5 Drop time, t, (s)	
Trial 6 Drop time, t, (s)	
Trial 7 Drop time, t, (s)	
Trial 8 Drop time, t, (s)	
Trial 9 Drop time, t, (s)	
Trial 10 Drop time, t, (s)	
Average drop time (s)	
t2 (s2)	

2. Hypothesize an experimental value of *g* obtainable through this simple stopwatch timing experiment.

   Hypothesis on the experimental value of *g*: _____ m/s^2

3. Use the tape measure to measure and mark a vertical distance of 2 m from the floor.
4. Stand on a solid chair and hold a small object, like a marble, at the marked height. Have a partner use a stopwatch to record the time it takes for the object to fall 2 m.
5. Tell your partner when to start timing as you drop the ball. Have the timer watch when the ball hits the floor so they can stop timing.
6. Record this time as "Trial 1 Drop time, *t*, (s)" in Data Table 3. Record to the nearest tenth of a second.
7. Conduct Trials 2-10 by dropping the object and recording the times in Data Table 3.
8. Calculate the average drop time of the object, and record in Data Table 3.
9. Take the square of this average time and record in Data Table 3, row "t^2 (s^2)."
10. Calculate g using the equation $g = 2d/t^2$ and record it into Data Table 3.
11. Compare the calculated magnitude of acceleration due to gravity to your hypothesis made in step 2. How close was your hypothesis to the results obtained in this exercise?

