DATE _____ PERIOD _____ NAME _____

EXPERIMENT

4.2 Acceleration Due to Gravity

Purpose

Observe a falling object and determine the acceleration due to gravity.

Concept and Skill Check

The recording timer can be used to record the displacement of a falling mass. The resulting tape is used to analyze the accelerated motion of the mass. In this experiment, you must know the period of the timer. If the period is unknown, use the procedure described in Experiment 2.3 to determine this value.

The average velocity during an interval of time is found by the equation

$$v = \frac{\Delta d}{\Delta t},$$

where Δd is the distance traveled during an interval of time, Δt. A uniformly accelerated object will produce a straight (but not horizontal) line on a graph that plots velocity versus time. The slope of the velocity versus time graph is the acceleration. The slope is found from the ratio

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{(v_f - v_i)}{(t_f - t_i)}.$$

An object dropped from rest will travel a distance given by the following equation

$$d = \frac{1}{2} g t^2.$$

Therefore, since d and t have been measured, g may be calculated from

$$g = \frac{2d}{t^2}.$$

The Free Fall Adapter apparatus uses the computer to measure accurately the time required for a steel marble to fall from the top of the free fall apparatus to a sensor pad. The computer software averages the times for the trials and, after the free fall distance is entered, calculates the acceleration due to gravity.

Materials

Part A

recording timer with necessary power supply
timer tape
carbon discs
C-clamp
masking tape
1-kg mass
meter stick
graph paper

EXPERIMENT 4.2

Acceleration Due to Gravity

NAME _____

Procedure

Part A

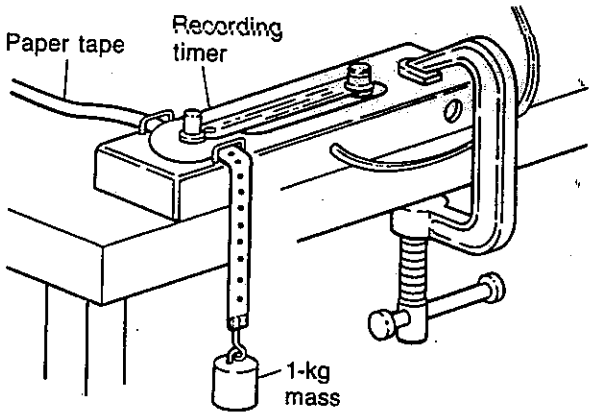

Figure 1.

1. Record the period of your recording timer on the line provided above Table 1.
2. Set up the apparatus as shown in Figure 1. Insert a 1.5-m strip of timer tape into the recording timer. Use the masking tape to attach the timer tape to the 1-kg mass.
3. Start the recording timer and drop the mass. Stop the recording timer when the mass hits the floor.
4. Remove the timer tape from the mass and write a zero below the first distinguishable dot. Number every subsequent dot consecutively 1, 2, 3, 4, 5, and so on. The elapsed time for the intervals can be determined by finding the product of the interval number and the period of the timer. Calculate the time for each interval and record these values in Table 1.
5. Carefully measure in meters the distance traveled during each interval of time (the space between dots). Record the displacement during each interval in Table 1.
6. The total displacement from zero to any numbered point along the timer tape is the sum of the measured distances between consecutive numbers on your tape. Record in Table 1 the total displacement of the mass during the corresponding intervals.
7. Calculate the average velocity during each interval and record these values in Table 1.

Analysis

Part A

1. On graph paper, plot the total displacement of the mass versus time. Use the values in Table 1.
2. On graph paper, plot the average velocity versus time. Use the values in Table 1.
3. Write a brief explanation describing what the graph of total displacement versus time indicates about the motion of the falling mass.

4. Study the graph of velocity versus time. Write a brief explanation of what the graph indicates about the motion of a falling mass.

5. Calculate the slope of the velocity versus time graph. Compare your results for acceleration due to gravity to the reference value, 9.80 m/s^2, by finding the relative error.

$$\text{relative error} = \frac{(\text{experimental result} - \text{reference value})}{\text{reference value}} \times 100\%$$

Acceleration Due to Gravity

Observations and Data

Table 1

Frequency of spark timer:_____Hz

Period of spark timer: _____sec

Interval	Total Time (sec)	Total Displacement (cm)	Total Displacement (m)	Average Velocity (m/sec)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
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