Kuwait University	Course 125 Phys. Lab. I
Physics Department	Experiment 5: Free Fall

Acceleration due to gravity from free fall

Objectives

- To study the free fall motion
- To find the acceleration due to gravity from free fall time(t) of bodies with different masses
- To draw the relation between falling distance and time and calculate (g)

Equipment to be used

- Experimental setup for free fall (Figure 1)
- Steel balls of different masses
- Measuring devices:

  ruler

  Free fall timer

References:

R. A. Serway, Physics for Scientists and Engineers, Section 3.5. Freely Falling Bodies.

Douglas. C. Giancoli. Physics Principles with applications, (3^{rd} edition), Chapter 2.

D. Halliday, R. Resnick and J.Walker, Fundamentals of Physics, Chapter 16.

Theory

By a freely falling body we mean that a body that is uniformaly accelerated by the influence of the gravitational acceleration when air resistance is negligible. In vacuum, all falling objects have the same acceleration due to gravity. In reality; however, different objects have slightly different acceletations due to air influence on there motion. when a body is falling freely through the air, the effect of air friction depends on size, shape, density, and surface area of the falling object. This friction naturally reduces their acceleration.

The equations of motion for constant acceleration can be applied to the freely falling objects near the earth's surface. The position of a falling object during its vertical flight as a function of time can be shown as:

$$y(t) \;=\; y_o + v_o t + \frac{1}{2} g t^2 \tag{1}$$

where y_o is the initial position of the falling object, v_o is its initial velocity at time $t = 0$, the term ($y(t) \;-\; y_o$) is the falling hieght h whish is the distance the object has traveled from its starting point during time t, and g is the acceleration due to gravity. The magnitude of g at sea level and 45^o latitude is equal to 9.80665 m/s^2. This magnitude of g may by slightly different from one position to another on the earth's surface depending on how far are we from the center of the earth. In this experiment if we consider the falling object to start its motion from rest then equatuin 1 will be simplified to :

$$y(t) \;-\; y_o \;=\; h \;=\; \frac{1}{2}\; g\; t^2 \tag{2}$$

you will study this relation between the heights of two falling objects (steel balls) and time, and calculate the value of g for each one of them using the relation:

$$g \;=\; \frac{2h}{t^2} \tag{3}$$

If your results obtained with different heights fit the law in equation 1, then g should be constant and you can use your experimental results for the determination of g.

Experiment A: Free fall

Procedure

A1. Set up the free fall apparatus as shown in Figure 1. Use the frist steel ball.

A2. Set the height h to approximately 0.4 m. **Measure** the height and record it in Table 5.1. Press the *Reset button* on the timer, then loosen the thumbscrew so that the ball drops. **Record** the fall time t in Table 5.1.

A3. Repeat step A2 four more times for the same height and **record** the falling time t .

Repeat steps A1 and A2 for different heights by increasing the value of h by 10 cm each time. For each height **record** the fall time in Table 5.1.

A4. Calculate the average value $\bar{g}$ for the different heights.

A5. Plot the height h versus t^2 and get the acceleration due to gravity from the slope.

A6. Reprat steps A1 through A5 For a different steel ball and **record** your data in Table 5.2.

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Laboratory Assignment

1. Based on your results, the acceleration due to gravity in Kuwait has the accepted value $g =$

2. Why the acceleration due to gravity might depend on the coordinates on Earth's surface?

3. The free fall time and final velocity for a height of h m will be (fill the table):

height h in m	$t=$ s	v_{final} m/s
365 m (liberation tower)		
10 m (roof of your house)		
1.25 m (this experiment)		

4. Does the free fall time depend on the mass? explain?

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Worksheet for Experiment 5

Table 5.1: Free fall of steel ball (1)

height unit	1st meas.	2nd meas.	3rd meas.	4th meas.	5th meas.	$\bar{t}$	$g = \frac{2h}{\bar{t}^2}$

$\bar{g}$(from the table) =

g(from the graph) =

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Worksheet for Experiment 5

Table 5.2: Free fall of steel ball (2)

height unit	1st meas.	2nd meas.	3rd meas.	4th meas.	5th meas.	$\bar{t}$	$g = \frac{2h}{\bar{t}^2}$

$\bar{g}$(from the table) =

g(from the graph) =

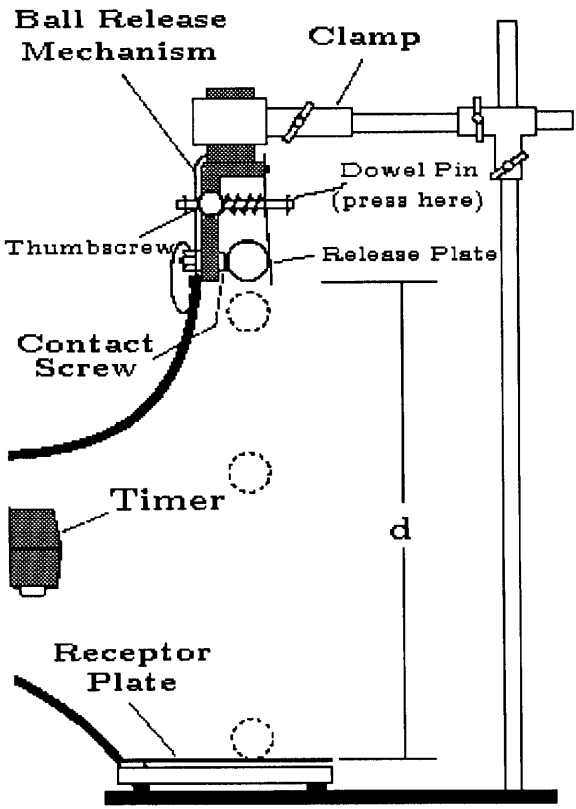

Figure 3.1 Experimental Setup