

Practical Work 1

Free-Fall Experiment

1. Objective of the Experiment

- To study uniformly accelerated rectilinear motion.
- To determine the acceleration due to gravity.

2. Theoretical Study

We shall study the motion of a body in free fall with no initial velocity.

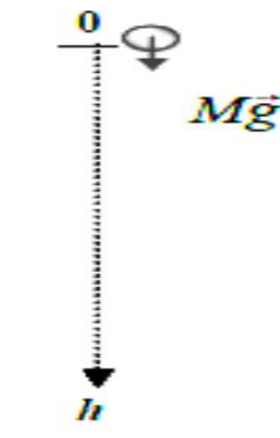


Figure 1:

In general, a body is in free fall (Figure 1) when the force exerted on it by the air is negligible compared with its weight.

The equation of motion of a ball falling freely with no initial velocity is given by:

$$h(t) = \frac{1}{2} g t^2 \quad (1)$$

Moreover, the velocity is given by the relation:

$$V(t) = g t \quad (2)$$

Where g is the acceleration due to gravity. $g = \text{Cte}$ (3)

Example

We know that the value of g varies from one region of the Earth's surface to another: for example, at the equator $g = 9.7804 \text{ m/s}^2$, and at the poles $g = 9.8322 \text{ m/s}^2$.

For Constantine, we take the following value of the acceleration due to gravity

$$g = (9.80 \pm 0.01) \text{ m/s}^2$$

3. Apparatus Used

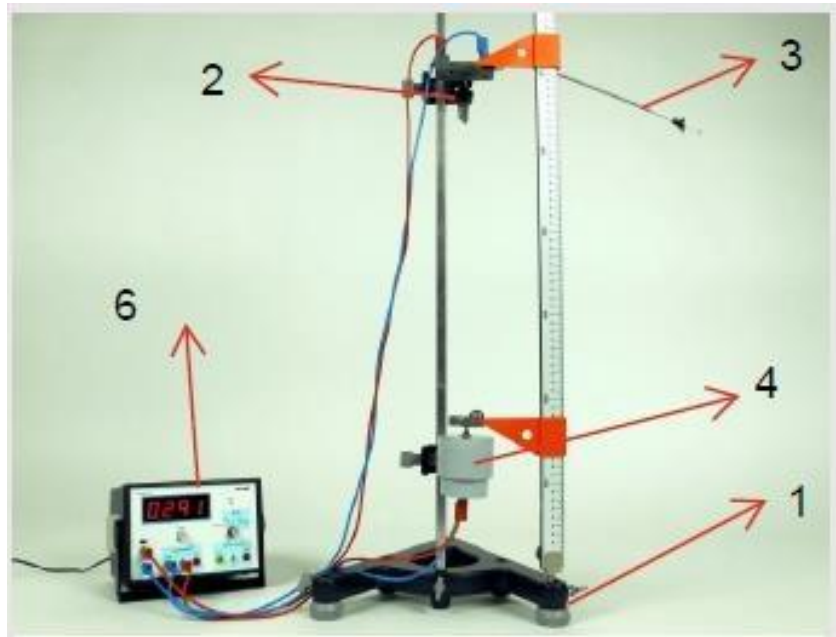


Figure 2

- 1. Support base:** it carries two rods; one holds the arrival and start sliders, and the other a ruler graduated in millimeters.
- 2. Start slider:** fixed on the vertical bar and connected to the release device and to the electronic counter.
- 3. Release device:** a device that holds the steel ball at the zero point of the start slider. When the ball is released, the circuit opens, which allows the fall time to be measured.
- 4. Arrival slider:** fixed on the vertical bar and connected to the electronic counter as shown in Figure 1. When the ball strikes it, the electrical circuit closes, and the electronic counter therefore stops counting.
- 5. Steel ball:** represents the falling body.
- 6. Electronic counter:** connected to the start slider and the arrival slider; it is used to measure time.
- 7. Connecting wires.**

On the fall, distance e is determined by estimating:

- **3.1 Δe_1 :** the accuracy of the alignment between the lowest point of the ball and the index mark of the start slider on the bar.
- **3.2 Δe_2 :** the accuracy of the alignment between the lowest point of the small disc of the arrival slider and the index mark of that slider on the bar.

Hence, the reading precision on the graduated bar is:

$$\Delta e = \Delta e_1 + \Delta e_2$$

4. Assembling the Apparatus

Assemble the apparatus as shown in Figure 2, and make the electrical connections as shown in Figure 3.



Figure 3: Chronometry digital

5. Experimental Procédure

In this experiment, we shall measure the time taken by the ball to fall from the start slider to the arrival slider, with zero initial velocity.

To carry out this experiment, follow the steps below:

1. Set the pointer of the graduated ruler to position H (Figure 4).
2. Set the counter switch to the symbol 
3. Attach the ball to the start slider.
4. Press the **Reset** button.
5. To release the ball, press the release device.
6. Record the time displayed on the counter screen.
7. Repeat the measurement five times for each of the positions listed in the table.

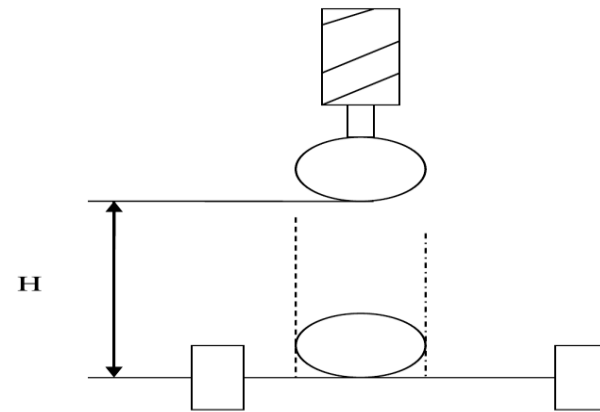


Figure 4



Call the instructor, and then carry out the first time measurement.

<i>Table of Expérimental Résultats</i>					
H (cm)	20	30	40	50	60
Δh					
t(s)	1.....	1.....	1.....	1.....	1.....
	2.....	2.....	2.....	2.....	2.....
	3.....	3.....	3.....	3.....	3.....
	4.....	4.....	4.....	4.....	4.....
	5.....	5.....	5.....	5.....	5.....
t $\approx$					
σ_{tcal}					
$\sigma_t \approx$					
t² cal					
t² $\approx$					
V exp cal					
V exp $\approx$					
g exp cal					
g exp $\approx$					
Δg_{exp} cal					
$\Delta g_{exp} \approx$					
g exp moyen					

6. Questions

1. Complete the table.
2. On millimeter graph paper, plot the graph $H = f(t_m^2)$, showing the error bars for each point.
3. What is the nature of the motion? Deduce from the graph the experimental value of the acceleration due to gravity, g_{exp} .
4. Compare this value with the value $g_{\text{exp, mean}}$.
5. Calculate the absolute and relative errors in the acceleration due to gravity at $H = 0.4 \text{ m}$. Given $\Delta H = 2 \text{ mm}$, $\Delta t = 0.001 \text{ s}$.
6. In this case, write the acceleration due to gravity in the form:

$$g = g_{\text{exp}} \pm \Delta g$$



Leave the workstation as you found it.