

# **PHYSICS LAB REPORT**

## **Gravity and Acceleration**

**Aim:** To show that the acceleration of a freely falling body is equal to the gravitational pull of the Earth. To give a comparison of the various values obtained using different methods and show how external factors play a role in the measurement of the acceleration of a body.

**Hypothesis:** If a body is dropped from a height then its acceleration will be equal to the gravitational pull of the earth because a freely falling body is attracted towards the earth due to its gravity independent of the mass of the object and neglecting air resistance.

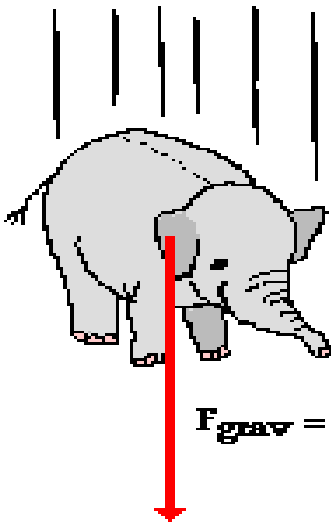
**Abstract:** In this experiment the following principles will be investigated.

- If an object held near the surface of the earth is released, it will fall and accelerate, or pick up speed, as it descends. This acceleration is caused by gravity, the force of attraction between the object and the earth.
- Falling objects accelerate in response to the force exerted on them by Earth's gravity. Different objects accelerate at the same rate, regardless of their mass.

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The acceleration of a freely falling body is equal for all masses but due to air resistance it varies. In this experiment the acceleration of falling bodies are calculated and compared using two different set - ups.

$m = 1000 \text{ kg}$



$F_{\text{grav}} = 10\,000 \text{ N}$

$$a = \frac{F_{\text{net}}}{m} = \frac{10\,000 \text{ N}}{1000 \text{ kg}}$$

$$a = 10 \text{ m/s/s}$$

$m = 1 \text{ kg}$



$F_{\text{grav}} = 10 \text{ N}$

$$a = \frac{F_{\text{net}}}{m} = \frac{10 \text{ N}}{1 \text{ kg}}$$

$$a = 10 \text{ m/s/s}$$

### Apparatus:

1. Ticker Tape
2. Retort stand
3. Pulley
4. String
5. Weight
6. Photogate
7. Lab Pro Interface
8. Picket Fence
9. Trolley
10. Laptop/computer

## **Method:**

### Using the Photogate:

1. The lab pro interface is connected to the photogate and the laptop. (Logger pro software is required in the laptop)
2. The lab pro is switched on and it is ready to be used when the 3 indicator lights blink.
3. The photogate is kept in an upright position.
4. The picket fence is held over the photogate but not too far away as the laser needs to be cut when the picket fence falls.
5. On the laptop the collect button is pressed and simultaneously the picket fence is released.
6. Once the whole picket fence has passed through the photogate the data is collected by the logger pro software.
7. The logger pro draws a graph using the given data and the slope represents the acceleration of the body.

### Using the Ticker Tape:

1. The Ticker Tape is placed on a table. The tape is fixed to the end of the trolley.
2. The other end of the trolley is tied to the string.
3. The string is tied to a weight which is held in place by the pulley and the retort stand.
4. The weight is placed at the edge of the table.
5. One person holds the weight while another holds the trolley and gets ready to hit the switch of the ticker tape.
6. When the signal is given the weight is released and simultaneously the trolley is released and the switch is turned on. This accelerates the trolley forward.
7. Once the weight hits the ground the ticker tape is switched off and this tape will now have markings (dots) on it.

8. Now the strip is cut into strips of 10 dots each and a graph is made which will help to calculate the acceleration of the trolley.

### **Data Collection:**

#### Photogate:

Given below is the table of the readings taken using the photogate for acceleration of the picket fence. The graph obtained using the photogate shows a reading of 9.985m/s.

#### Logger Pro Column Data:

Time s	GateState	Distance m	Velocity m/s	Acceleration m/s <sup>2</sup>
0.0212828	1	0		
0.0431212	0			
0.0628832	1	0.05	1.4057	9.799
0.0790828	0			
0.0948828	1	0.1	1.7219	9.96
0.1083	0			
0.121821	1	0.15	1.987	9.78
0.13352	0			
0.145584	1	0.2	2.2248	10.16
0.156083	0			
0.167009	1	0.25	2.439	9.83
0.176583	0			
0.186725	1	0.3		
0.195618	0			

#### Observation:

While using the logger pro software the picket fence was released half way after the time limit.

The laser of the photogate must be cut by the picket fence before it is released.

### Ticker Tape:

The table given below shows the two variables distance and time and their velocity in the experiment done using the ticker tape that was taken from the graph.

Distance (cm)	Time (s)	Velocity(cm/s)
4.2	0.2	21
8.8	0.4	43.5
13.5	0.6	67.5
18.1	0.8	90.5
19.6	1.0	98

### Observation:

During the experiment the ticker tape got ripped off due to the heavy weight and so the weight was reduced and the experiment was carried on.

An accurate reading cannot be obtained as:

- The distance covered by the trolley before it stops is short.
- Inclination of the string.
- Friction caused between the string and the stand.

## **Data Analysis:**

### Photogate:

In this experiment the closest value for acceleration due to gravity is  $9.799 \text{ m/s}^2$  at  $0.06\text{s}$ .

This is close to the gravitational force of  $9.8 \text{ m/s}^2$ . The slope of the graph shows an acceleration of  $9.985 \text{ m/s}^2$ .

From this we can calculate the error%.

Error = Difference between the reading obtained and the actual reading / actual reading.

$$\begin{aligned}\text{Error \%} &= \frac{9.985 - 9.8}{9.8} * 100 \\ &= 1.887 \%\end{aligned}$$

### Tickertape:

$$\begin{aligned}\text{Acceleration} &= \text{slope of the graph} \\ &= \frac{98-90.5}{1.0-0.8} \\ &= 37.5 \text{ cm/s}^2 = 0.375\text{m/s}^2\end{aligned}$$

$$g = \frac{(M - m) a}{m}$$

Where M is the mass of the trolley, m is the mass of the weight, a is the acceleration and g is the gravitational pull.

$$= \frac{(0.96 - 0.1) 0.375}{0.1} = 3.225\text{m/s}^2$$

$$\text{Error \%} = \frac{9.8-3.225}{9.8} * 100 = 67.09\%$$

According to this value of acceleration the value of g should be  $3.225\text{m/s}^2$  which proves that there are errors in the experiment.

The reason for this is that the weight is not allowed to freely fall and this causes a variation in the acceleration.

## **Conclusion:**

From the above experiments we can see that acceleration of a freely falling body would be equal to gravity if it wasn't for the external factors the variables. One of the main factors is air resistance. Also the value for the photogate is much more accurate as air resistance is low and there is no friction involved.

## **Evaluation:**

- Weight used in the ticker tape experiment must not be too heavy.
- If the ticker tape were to be removed then the results could be more accurate.
- The length to be covered by the trolley before it stops must be increased.
- The whole pulley system could be eliminated and only the weight and the ticker tape could be used. The weight can be released and the ticker tape fixed to it. This will give us the acceleration during freefall.