Predicting Parabolic Motion

**Purpose:** Comparing measurements of physical quantities like time, velocity and displacement in parabolic motion with calculated values of the quantities using equations of motion, which are as follows:

1. **v = u + at**
2. **s = ut + ½ at2**
3. **v2 – u2 = 2as**

**Setup:** Placing a Toy Gun at a height of 63 cm above the ground, and firing it at different angles while recording it in slow motion to take accurate measurements.



**Experiment 1.**

<https://drive.google.com/drive/folders/1fkPkRp-MEeLigbzNdyFOraok5RssHDnz?usp=sharing>

VIDEO OF EXPERIMENT.1

**Inclination of Gun:** 0o

|  |  |  |
| --- | --- | --- |
| Time of flight  | Horizontal Displacement  | Vertical Displacement  |
| 0.37 s  | 3.82 m  | -0.63 m  |

From 2nd equation of motion

 Sx = uxt + ½ axt2

 = 0 - ½ \*9.8ms-2 \* (0.37s) 2 … (As the gun is shot at 00, initial vertical velocity = 0 m/s)

= **- 0.67m**

Calculated vertical displacement **=** **-0.67m**

 Measured vertical displacement **= - 0.63m**

* margin of error **= 6.35%**

**Calculating the initial velocity of the bullet:**

As the gun is fired at 0o angle, it has no initial vertical velocity.

Therefore, its horizontal velocity is its initial velocity.

Horizontal Velocity = Horizontal Displacement / time of flight

= 3.82m/0.37s

**= 10.324 m/s**

**We will now use this velocity to predict the motion of the bullet when it is shot at a different angle and compare it with the measurements taken.**

**Experiment 2.**

<https://drive.google.com/drive/folders/14u98L3Yg5IkLj1Ybx9uo4wUiOb2Y-VWZ?usp=sharing>

VIDEO OF EXPERIMENT 2.

**Inclination of Gun**: 21.7o

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Time of flight | horizontal displacement  | vertical displacement  | horizontal velocity u cos(21.7)  | vertical velocity  u sin(21.7)  |
| 0.79s  | 7.6 m  | -0.0401 m  | 10.324m/s\* cos 21.7 = 9.592 m/s | 10.324m/s \*sin 21.7 = 3.817 m/s  |

**Horizontal displacement** = Horizontal velocity \* time

 = u\*cos (21) \* t

 = 9.592m/s \* 0.79s

Calculated from Experiment 1.

 = **7.578 m**

Calculated Horizontal Displacement **= 7.578 m**

Measured Horizontal Displacement **= 7.60 m**

* Margin of error **= 0.3%**

**Vertical displacement** = uxt + ½ axt2 (from 2nd eq. of motion)

 = u\*sin (21.7) t – ½ gt2

 = 3.817m/s \* 0.79 s – ½ \* 9.8 m/s2 \* (0.79s) 2

= - 0.04266 m

Calculated Vertical Displacement= **-0.04266 m**

Measured Vertical Displacement= **-0.0401 m**

* Margin of error= **6.4 %**

**Conclusion:** the results obtained from using equations of motion are very close to the measured ones. The margin of error observed is due to:

* Air resistance and uneven air flow
* Light weight of bullet (air flow affecting the motion)
* Accuracy of measuring instruments
* Minor difference in firing force of toy gun during each trial