Name of Student

Name of Instructor

Course Code

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Projectile Motion

Abstract

A projectile follows a path which can be expressed regarding algebraic equations. The vertical component of the projectile changes due to the action of the gravity force on the body. Gravitational force acts on the body in projectile motion. In the calculation of the properties of the movement, the resistance or the viscous drag of the air is neglected. The projectile accelerates downwards due to the effect of the gravity. The missile has inertial force due to its momentum. The inertial force maintains the horizontal component of the speed. The path in which the projectile traces is the trajectory. The projectile moves under the action of three forces. The forces include frictional forces due to air resistance, the gravity, and the lift force if the body behaves like a wing. The gravity force acting on the body is proportional to its weight. The effect of gravity works downwards. The frictional force is taken insignificant in most calculations. This paper investigates various parameters of projectile motion.

Keywords: Projectile, Inertia, Gravity, Displacement

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Introduction

The gravitational force is determined experimentally by use of a bouncy ball. The vertical speed of the ball is plotted against time. The gradient of the graph gives a value close to 9.81m/s2. The object thrown into the air is known as a projectile. The path in which the projectile traces is the trajectory (Hayen 360).

When a body is thrown into the air, the vertical velocity varies due to an action of the gravity while the horizontal component of the projectile is assumed to be constant. The projectile might be thrown at an angle from the ground or at zero degrees from the horizontal plane. The absolute velocity of the body launched into the air is divided into a horizontal component and the vertical component. The angle the body makes with the horizontal ground is the determinant of the two components of velocity (Hayen 362). The total velocity of the projectile is expressed using the Pythagorean Theorem.

$V^2 = Vx^2 + Vy^2$

Where V_x is horizontal displacement while V_y is vertical displacement.The rate of change of displacement changes as the time t changes. Mathematically it is expressed as $V = Vx + Vy$. Where V is the total velocity of the projectile. The two components of the projectile velocity are affected by the frictional force of the air if it is not negligible. However, in most cases, it is taken as insignificant. The frictional force of wind or the viscous drag acts in the opposite direction of the direction of motion. The rate of change of the velocity of the projectile is proportional to the air resistance coefficient. The air resistance force is taken very small when the Reynolds number is low. The frictional force due to air acting on the projectile is not commensurate with the velocity of the body at high speeds.

Experimental Details

Experimental principles: The Newton's laws of motion form the basis of the study of the projectile motion. The Newton laws can be used to determine the velocity, displacement, time and acceleration of the body at any instant. The velocity equations written above are derivatives of the Newton laws of motion.

Apparatus: The apparatus used in the experiment include the following:

i. Ballistic pendulum
ii. Meter sticks/ tape measure
iii. Carbon paper and white paper

Procedure

Part 1: Estimating the initial speed of the projectile

i. The launcher was placed on the desk and measured the vertical position relative to the ground.
ii. The launcher was fired three times using the medium-range setting. The position of the sling was at the same point every firing.
iii. The results for the vertical displacement and the horizontal displacement were measured and recorded. The values were used to calculate the initial speed.

Part 2: Using the kinematic model to predict the motion of projectile range for non-zero initial angle

i. The launcher was tilted and angle measured. The inclination was kept at the vicinity of 200. The bomber was fired three times and recorded the horizontal and vertical displacements.
ii. The difference between the experimental and theoretical values gave the expected error.

Results and Discussion

Part 1

Measured Vertical Displacement	Trials	Average Horizontal Displacement	Initial speed
Δ y= y-y0 = -1.1 m	First trial =2.2 m Second trial= 2.1m Third trial= 2.15m	$\Delta x = 2.15 m$	$v_0 = 4.57\,m/s$

Part 2

Measured vertical displacement Δ y = -1.100m	Number of Trials	Average X-axis Displacement	Error
Determined displacement = 2.8600m	First trial = 2.9m Second trial = 3.1m Third trial = 7.2m	Δ x= 3.07m	% E = 6.8

Calculations

Part 1

$S^2 = X_x^2 + Y_y^2$

S= (1.1*1.1 +2.15*2.15) ^0.5 = 2.415M

Velocity = Displacement/ time= 2.415/ 0.53= 4.57m/s

Part 2

Theoretical x= 2.86m

Y displacement = -1.1m

Average horizontal displacement = 3.0700m

Percentage error = (3.07-2.86) /3.07 = 0.068*100% = 6.8%

The initials speed = displacement / time = 3.07/0.5= 6.14m/s

The acceleration of the body is a component of the horizontal and vertical directions. The gravitational force pulls the object downwards. The vertical acceleration if the body is assumed to be equal to the negative of the gravity (-9.81m/s2). The horizontal acceleration of the body is taken as zero since the horizontal component of the remains constant. The acceleration of the body is however affected by external forces such as wind and air resistance (Parker 610). If the projectile is thrown against the wind direction, then the acceleration is lowered by the effects of the wind forces (Robinson 2013). If the body of the surface area acting against the wind direction is small, the factor is neglected.

V_x=Cos (t) represents the x-axis movement while V_y= Vsinθ denotes the y-axis motion. The horizontal speed of the body at any point is given as V_x. The vertical rate of change of displacement of the body at any point is expressed as V= V_y*t – gt where t is the time taken for the flight and g is the gravitational force.The significant causes of error were:

i. Reading errors in the displacement
ii. Inaccurate measurements
iii. Machine characteristic errors

The experiment can be done by firing the launcher at different angles of inclination and note the vertical and horizontal movements. Similar tests include the determination of gravitational force by use of a projectile.

Conclusion

The vertical height or displacement gives the exact position of the projectile of the body from the reference point. The angle at which the missile is launched into the air affects the maximum reachable height. The vertical component of the projectile velocity decreases until the body reaches the maximum height. The projectile decelerates as it moves in the y-displacement. Acceleration occurs as the body moves downwards. The acceleration is now positive thus the vertical velocity of the body increases with time until it reaches the ground. The analytical method provides the value of the parameters at given instance by use of the laws of motion. The height of the projectile is expressed as the distance from a given reference point.

Works Cited

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