ScienceCube

Projectile Motion

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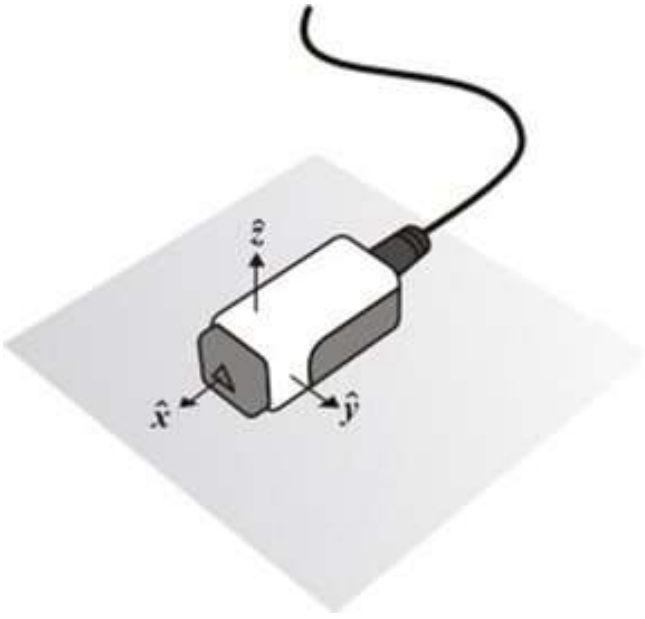
1. **The acceleration of a freely falling object and an object undergoing projectile motion can be measured and explained.**
2. **A microgravity environment can be created and explained.**

Fundamental Concept

1. **Understanding the Accelerometer**



A. Among the various methods to measure acceleration, the MEMS (micro-electromechanical systems) sensor that uses the principle of capacitor discharge is employed.

B. The accelerometer provides measured acceleration values within the range of gravitational forces. If the measured value of the accelerometer is 1.0, it means that a force of 1g (where 1g represents the gravitational acceleration of about 9.8 m/s^2) is acting in a particular direction.

C. In educational contexts, the observer's perspective is usually considered, so the 3-axis acceleration of a stationary object is described as 0g. However, since the accelerometer measures the magnitude of the tension caused by gravitational acceleration, if the sensor is stationary, it indicates that a force of 1g is acting in the direction of the Earth's pull.

2. **Acceleration of a Freely Falling Object**

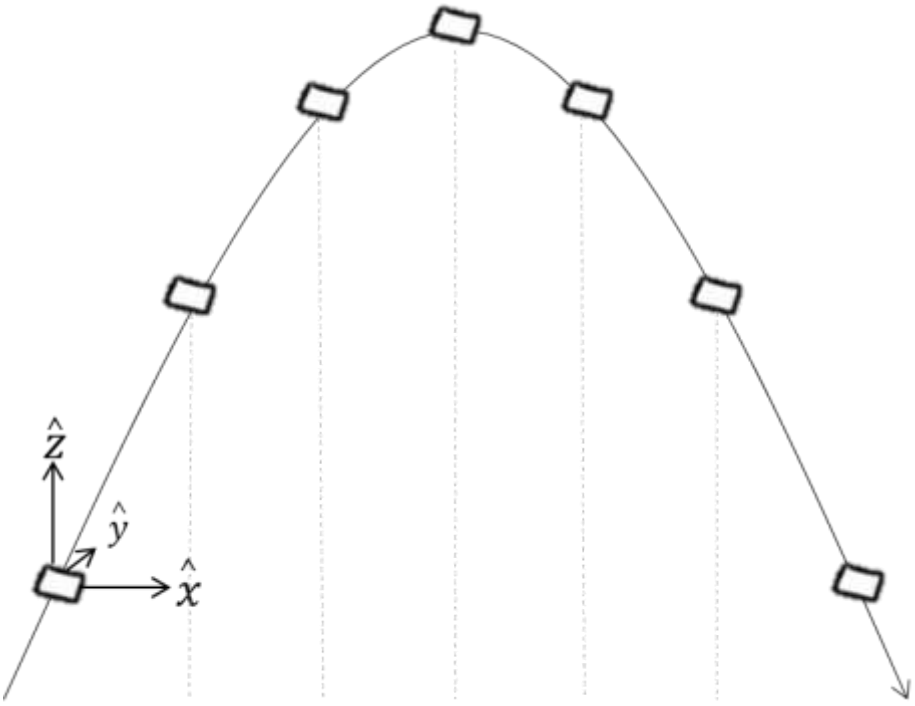
When dropping from a Viking ride or when an airplane is in free fall, the body feels weightless, as if gravity is not acting on it. Objects moving with the same acceleration as gravitational acceleration experience forces that cancel out, creating a microgravity environment, and the acceleration is 0.

< Microgravity in Spacecraft >

Microgravity is a state where gravity is approximately one-millionth of that on Earth, making it nearly negligible.

3. **Acceleration of an Object in Projectile Motion**

Projectile motion can be analyzed by decomposing it into horizontal (x-axis) and vertical (z-axis) motion. Each directional force only affects the motion in that direction, making projectile motion appear as independent linear motions happening simultaneously.



x-axis: Neglecting air resistance, an object in projectile motion experiences no horizontal forces, resulting in zero horizontal acceleration. Thus, horizontal velocity remains constant, exhibiting uniform linear motion.

y-axis: In projectile motion, no forces act in the y-axis direction, so the acceleration is zero.

z-axis: In the vertical direction, the object only experiences gravitational force, leading to uniformly accelerated linear motion with an acceleration equal to gravity. Objects moving with the same gravitational acceleration experience forces that cancel out, creating a microgravity environment with an acceleration close to 0(g).

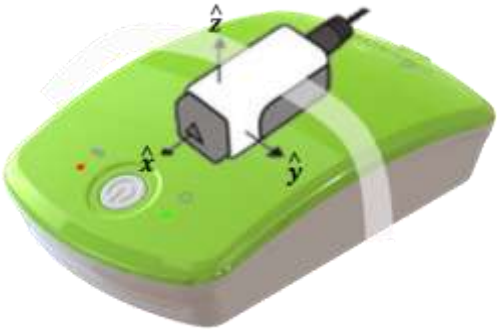
Experiment

Materials Needed

Interface, Science# program, accelerometer (or built-in sensor in a smart device), cushion

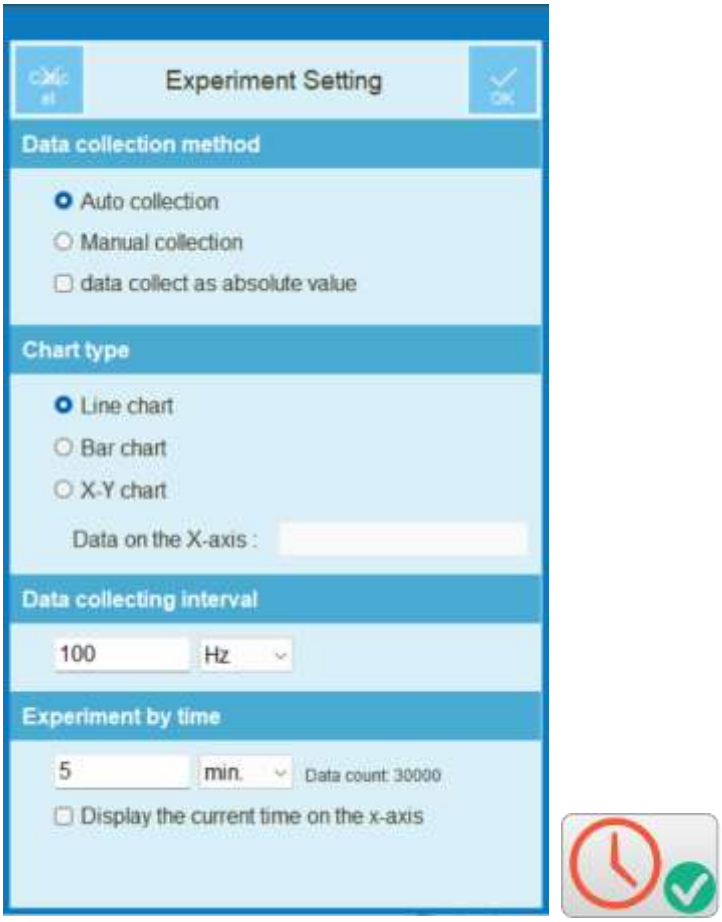
Experimental Setup

1. When using an accelerometer, securely attach the interface and accelerometer with cellophane tape to ensure they do not separate during the fall.



Interface Setting

1.  Run Science#.
2.  Press the button to set up the experiment environment as shown below or press the button  for automatic setup..

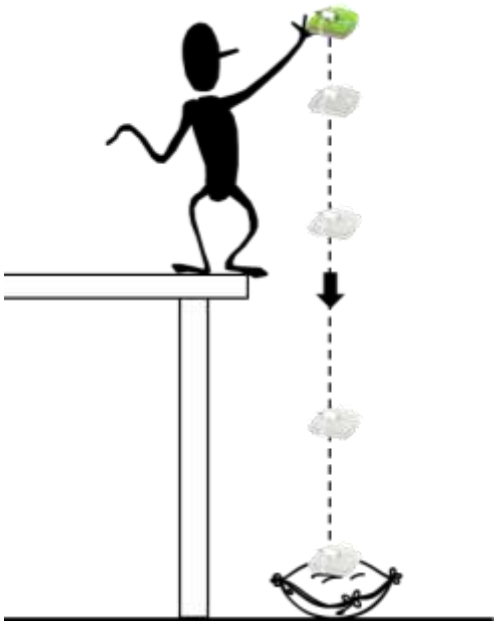


Data Collection

1.  Press the button to start data collection.

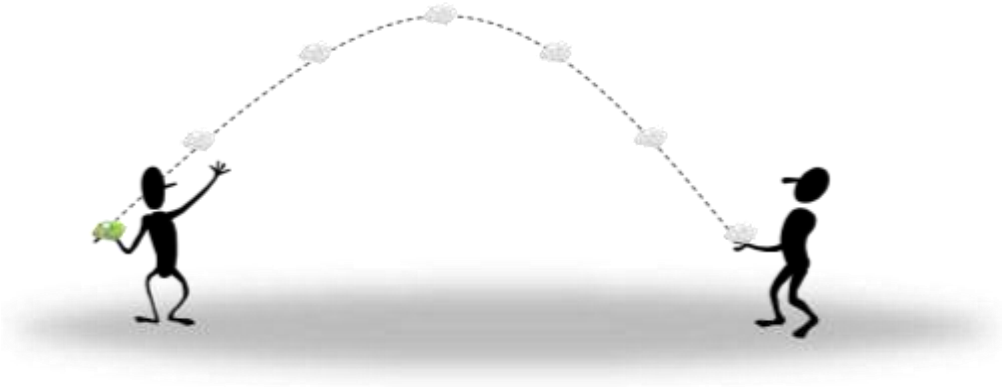
[Free Fall Motion]

2. Place a cushion at the drop point to avoid impact on the device during the fall.
3. Stand on a desk holding the sensor.
4. Drop the sensor, ensuring it does not sway or rotate during the fall..



[Projectile Motion]

5. In an area free of obstacles, have two people stand about 3 meters apart.
6. One person throws the sensor in a parabolic trajectory while ensuring it does not sway or rotate, and the other person catches it with both hands.



Data Analysis

Recording Data

1. Measure and plot the 3-axis acceleration of the freely falling object.

2. Explain the changes in 3-axis acceleration before (stationary) and after (in motion) the free fall.

3. Measure and plot the 3-axis acceleration of the object in projectile motion.

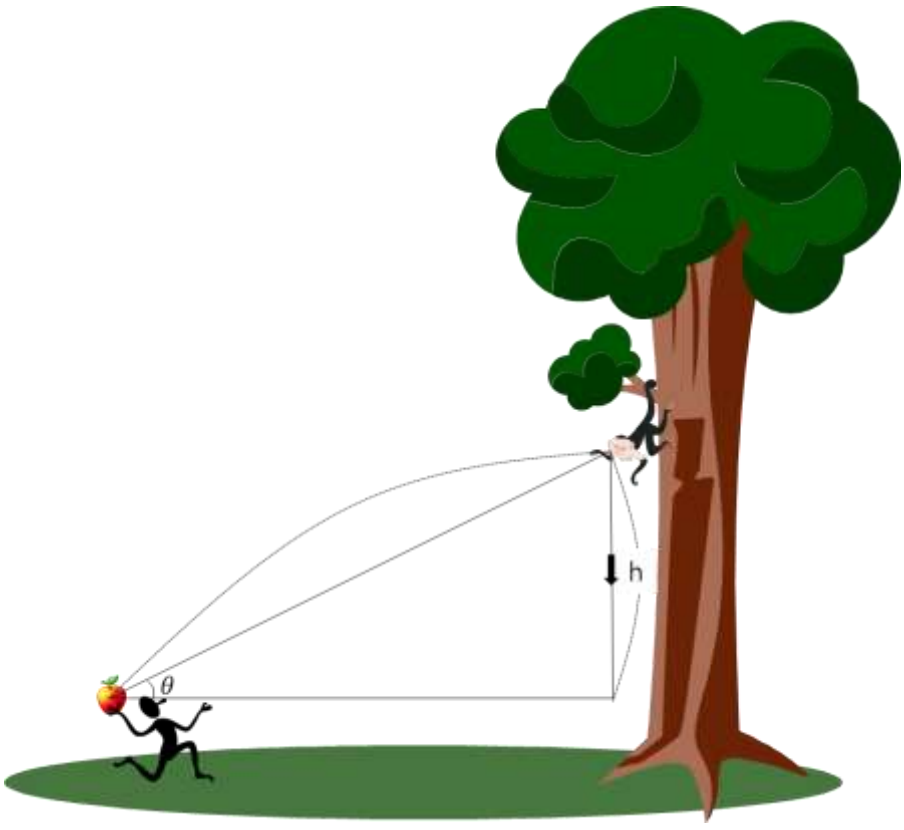
4. Explain the 3-axis acceleration of the object in projectile motion.

Applying Data and Extended Activities

1. At amusement parks, microgravity can be experienced. Describe the ride that offers a microgravity experience, its motion state, and your feelings during the experience.

Ride	Motion State	Feeling

2. In the illustration, a person is trying to throw an apple at a monkey on a tree. As the person throws the apple, the monkey is startled and falls. Indicate where the person should aim to hit the monkey and explain the reason.



3. Space agencies create a microgravity environment for training before spaceflight. Research and describe the methods used to create microgravity environments.

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Report
(For Teachers)
Report
(For Students)