ScienceCube

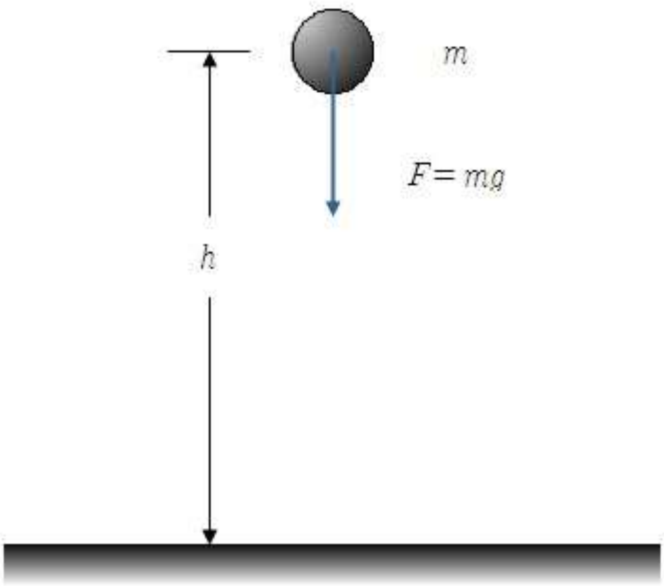
Speed of Falling Motion

1. **Measuring the speed of a freely falling object and comparing the speed measured at various positions.**
2. **Calculating the acceleration through the speed of a freely falling object and understanding it as gravitational acceleration.**

Fundamental Concept

1. Free Fall Motion

When you release a ball from your hand, the ball falls vertically without air resistance, influenced only by gravity. This motion of an object falling under the influence of gravity alone is called free fall..



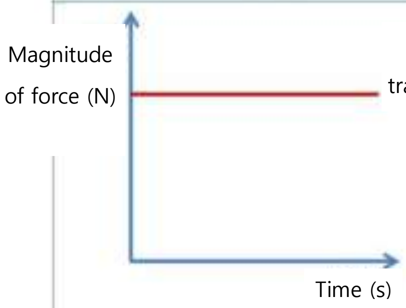
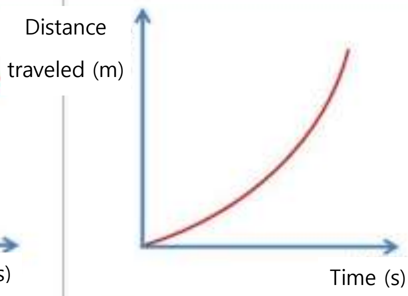
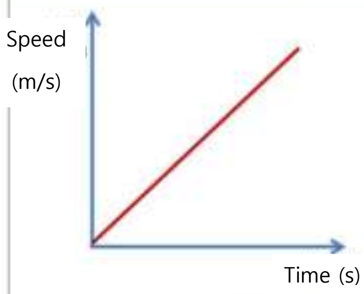
Free fall is a representative example of uniformly accelerated linear motion. Near the Earth's surface, when gravity acts on an object, it causes an acceleration of 9.8 m/s² downward, regardless of the object's mass. This acceleration caused by gravity is called gravitational acceleration, denoted as g.

1) Force acting on a falling object: Gravity

2) Direction of motion: Towards the center of the Earth

3) Magnitude of the force acting on the object, distance traveled, and speed of the object

   When observing the changes in the magnitude of force, distance traveled, and speed during free fall motion over time, we see that a constant force (gravity) continuously acts in the direction of motion, resulting in an increase in distance traveled over time. The speed increases uniformly over time.

<table>
<tr><th>Magnitude of force over time</th><th>Distance traveled over time</th><th>Speed over time</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>A constant force (gravity) continues to act in the direction of the object's motion</td><td>Distance traveled increases over time</td><td>Speed increases uniformly over time</td></tr>
</table>

2. Actual Falling Motion in Air

1) When there is air resistance

   Forces acting on a falling object: Gravity and air resistance

2) Characteristics of motion

   When an object falls in air, air resistance acts in addition to gravity, changing the rate at which the object's speed increases.

Experiment

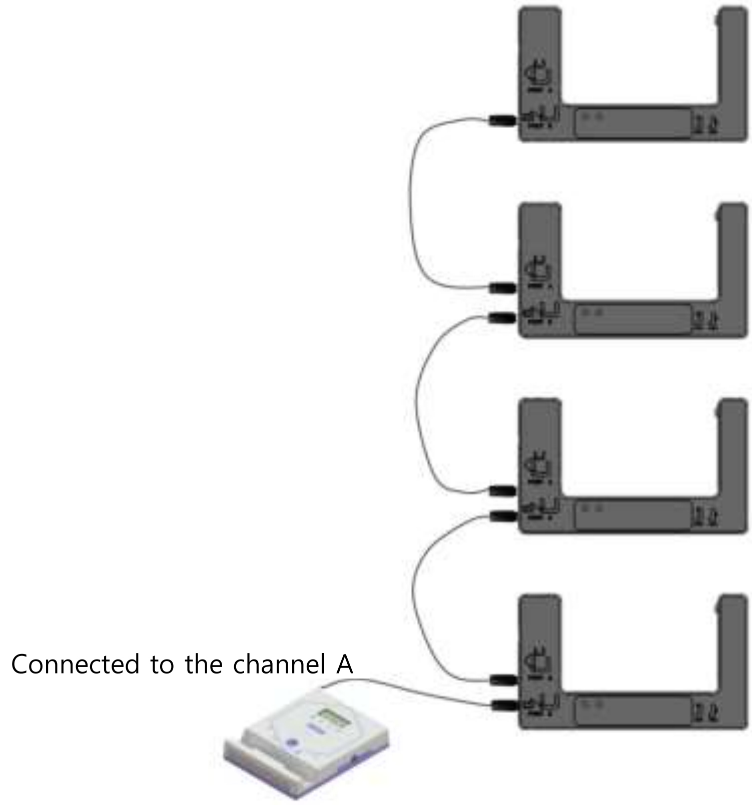
Materials Needed

Interface, Science# Program, 4 photogates, dynamics rail, photogate mounting bracket, falling ball, string, cushion, (stand, lighter)

Preparation of Experimental Apparatus

1. Cut a string about 20 cm long and tie it to the falling ball's attachment ring.
2. Secure the photogate mounting brackets at regular intervals on the dynamics rail.
3. Secure the photogates in a row facing the same direction on each mounting bracket.
4. Position the photogates at regular intervals about 2 cm from the dynamics rail.

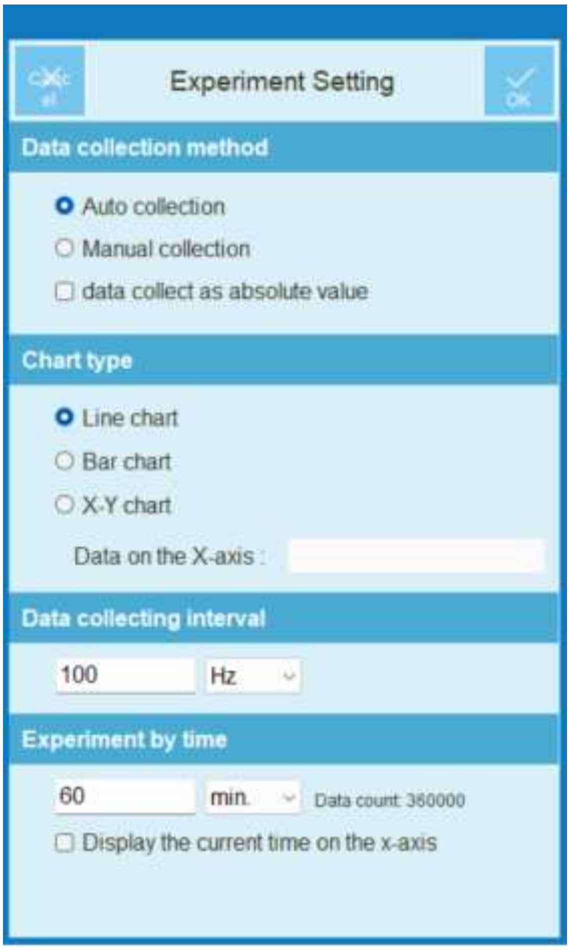
5. Connect the 4 photogates and the interface using cables as shown below.



6. Stand the dynamics rail vertically, and place a shock-absorbing device like a sponge on the floor to cushion the impact when the ball falls.

Interface Setup

1. Run the Science# program.
2. Connect the interface to Science# via Bluetooth or cable.
3. Click to set up the experimental environment as shown below or click to automatically set up.

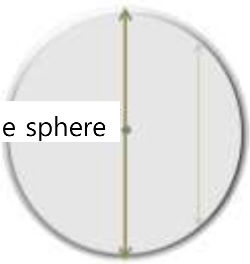


Sensor Setup

Click to set the sensors as shown below. Measure the diameter of the falling ball and input it as the length (L) of the object.

* Since it is difficult for the actual falling ball to drop precisely along the central axis in a straight line, a smaller diameter than the actual diameter may be measured. Therefore, enter a value approximately 1 cm smaller than the measured diameter.

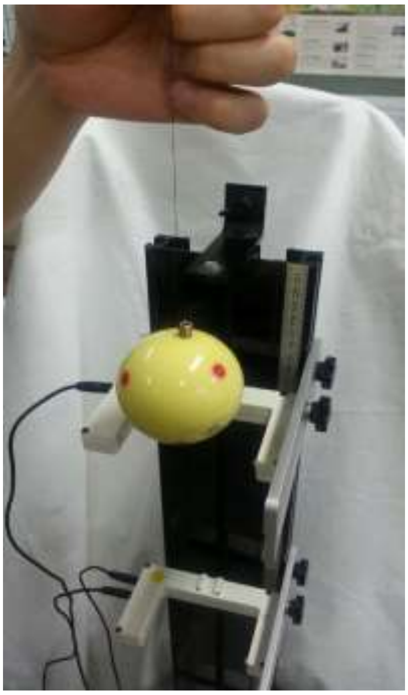
Diameter of the sphere



Data Collection

1. Position the falling ball so that it can pass through all 4 photogates when dropped vertically. Hold the string at the appropriate spot.
2. Click ▶ to start data collection and release the string to drop the ball.

   * For more accurate data, tie the string to a stand and burn it with a lighter to release the ball.

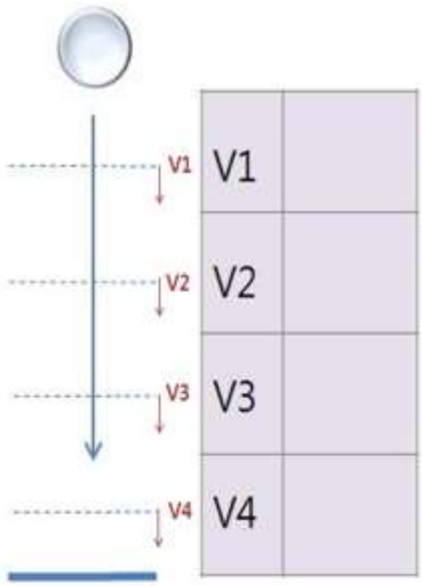


3. Click to end the experiment.
4. Repeat the same experiment 5 times to collect data..
5. Select the most ideal data graph and click , then select [Linear f(X)=Ax + B] in the basic analysis to fit a straight line and calculate the slope of the graph.

Data Analysis

Recording Data

1. Record and plot the speed of the ball measured by the photogates at each height in a graph or table.



2. Analyze the [time-speed] graph using the analysis function to display it as a linear graph, and record the slope value.

Data Application

1. Describe how the speed changed over time while the ball was falling and explain the reason.

2. Find the meaning of the slope in the [time-speed] graph.

3. Select all correct statements about the motion of a feather and a steel ball falling in air and in a vacuum from the list below..

A. In a vacuum, the steel ball and feather fall at the same time.

B. When falling in air, the steel ball and feather fall with uniform motion.

C. The reason the feather falls more slowly in air is due to air resistance.

Report
(For Teachers)

Report
(For Students)