ScienceCube

Mechanical Energy According to Height

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1. **Measure and compare the speeds of a freely falling object from different heights.**
2. **Calculate and compare the mechanical energy of an object at different heights and explain the loss of mechanical energy.**

Fundamental Concept

1. Mechanical Energy

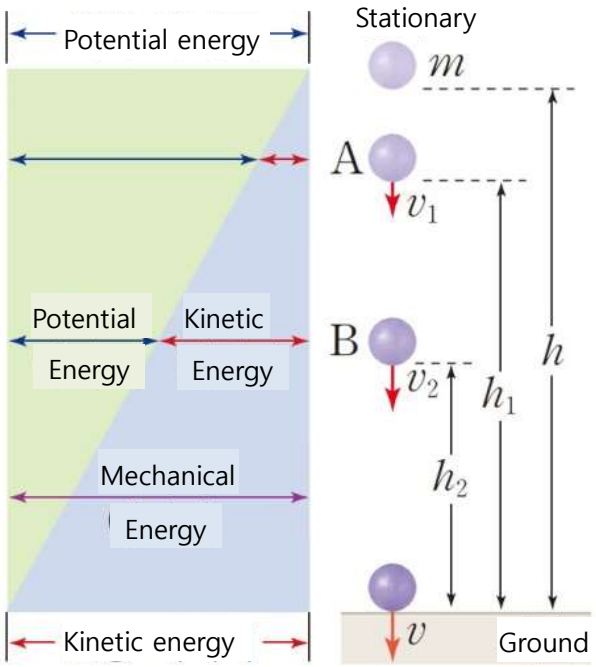
The sum of potential energy and kinetic energy that an object possesses..

1) Law of Conservation of Mechanical Energy: If there is no friction or air resistance, the mechanical energy of an object is always conserved.

2) Conversion of Potential and Kinetic Energy when Mechanical Energy is Conserved

- When an object falls: Height decreases (potential energy decreases), speed increases (kinetic energy increases) → Potential energy converts to kinetic energy → Decrease in potential energy = Increase in kinetic energy.
- When an object rises: Height increases (potential energy increases), speed decreases (kinetic energy decreases) → Kinetic energy converts to potential energy → Increase in potential energy = Decrease in kinetic energy.

2. Conservation of Mechanical Energy in Falling Motion



1) Decrease in potential energy from A to B = Increase in kinetic energy from A to B

$$9.8mh_1 - 9.8mh_2 = \frac{1}{2}mv_2{}^2 - \frac{1}{2}mv_1{}^2$$

2) Mechanical energy at point A = Mechanical energy at point B

$$9.8mh_1 + \frac{1}{2}mv_1{}^2 = 9.8mh_2 + \frac{1}{2}mv_2{}^2$$

3. Law of Conservation of Energy

Energy can be converted into various forms, but the total amount is always conserved. However, if there is friction or air resistance, mechanical energy is not conserved and some is converted into thermal energy, sound energy, etc.

Mechanical energy + Thermal energy + Sound energy + ... = Constant

Experiment

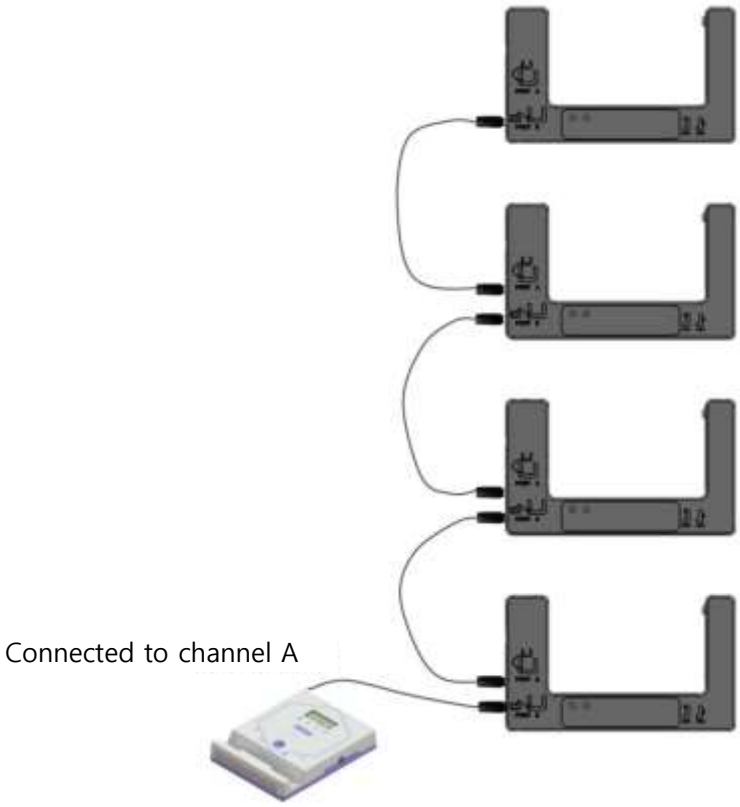
Materials Needed

Interface, Science# Program, 4 photogates, dynamics rail apparatus, 4 photogate mounting brackets, falling ball, string, cushion, tape measure, electronic scale

Preparation of Experimental Apparatus

1. Cut a string about 20 cm long and tie it to the attachment ring of the falling ball.
2. Secure the 4 photogate mounting brackets at regular intervals on the dynamics rail apparatus.
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..

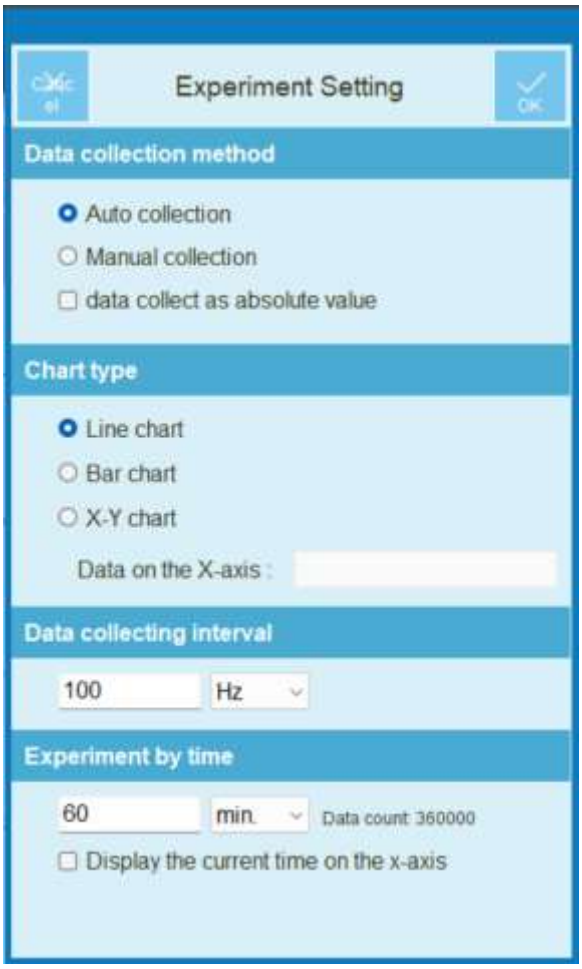
5. Connect the 4 photogates and the interface using cables as shown below.



6. Stand the dynamics rail apparatus 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.

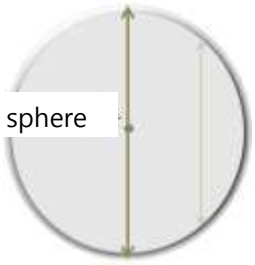


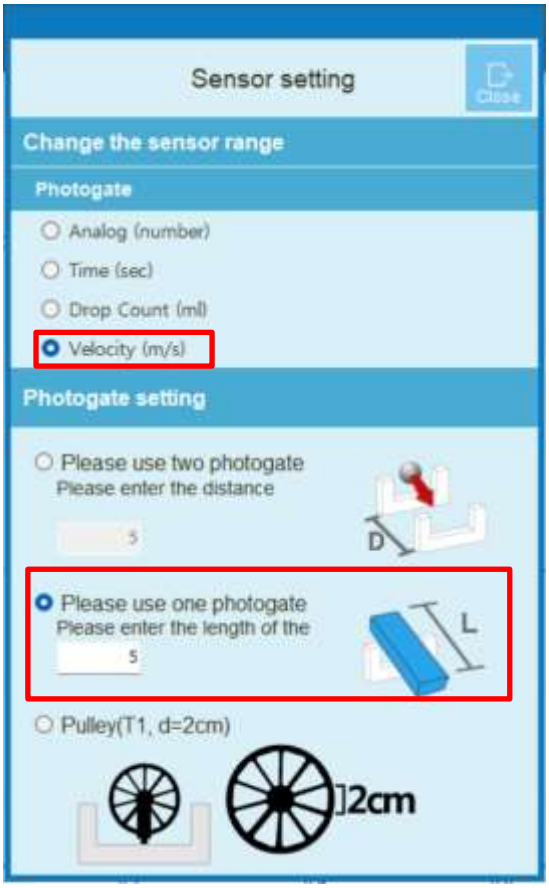
Sensor Setup

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..

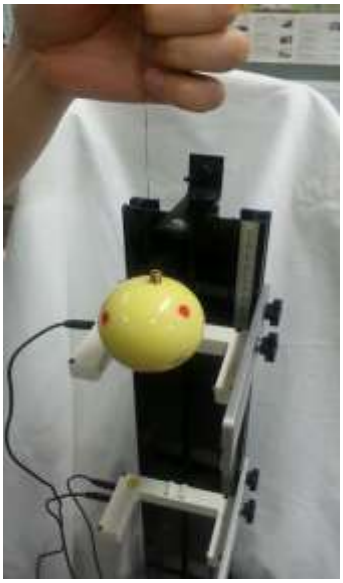
Diameter of the sphere





Data Collection

1. Hold the string to position the ball so that it can pass through all 4 photogates when dropped vertically.
2. Click  to start data collection and release the string to drop the ball.

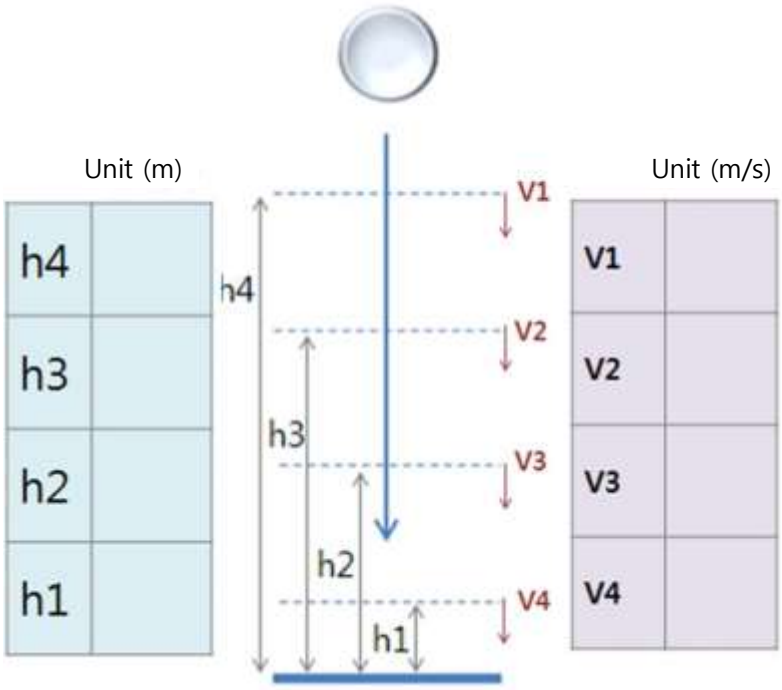


3. Click  to end the experiment.
4. Repeat the same experiment 5 times to collect data.
5. Click  to view the speeds measured by the photogates at each height in a table format.

Data Analysis

Recording Data

1. Record and plot the speeds measured by the photogates at each height, measure the height from the floor to the photogates, and record these values in the table along with the speeds.



2. Measure and record the mass of the falling ball.

Mass	Kg

Data Application

1. Using the measured heights and speeds at each height, calculate the mechanical energy.

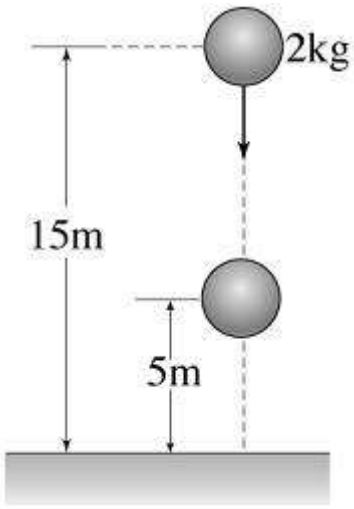
Height	Potential Energy	Kinetic Energy	Mechanical Energy

h1			
h2			
h3			
h4			

2. Describe how the potential energy, kinetic energy, and mechanical energy change as the ball falls, and explain the reason. (Indicate 'increase' or 'decrease')

Potential Energy	
Kinetic Energy	
Mechanical Energy	

3. A 2 kg object is dropped from a height of 15 m as shown in the diagram. Calculate the ratio of potential energy Ep to kinetic energy Ek when the object passes 5 m above the ground. (Assume air resistance is negligible)




Report
(For Teachers)
Report
(For Students)