Simple Pendulum Motion

1. **Identify and explain the factors that influence the period of a pendulum.**

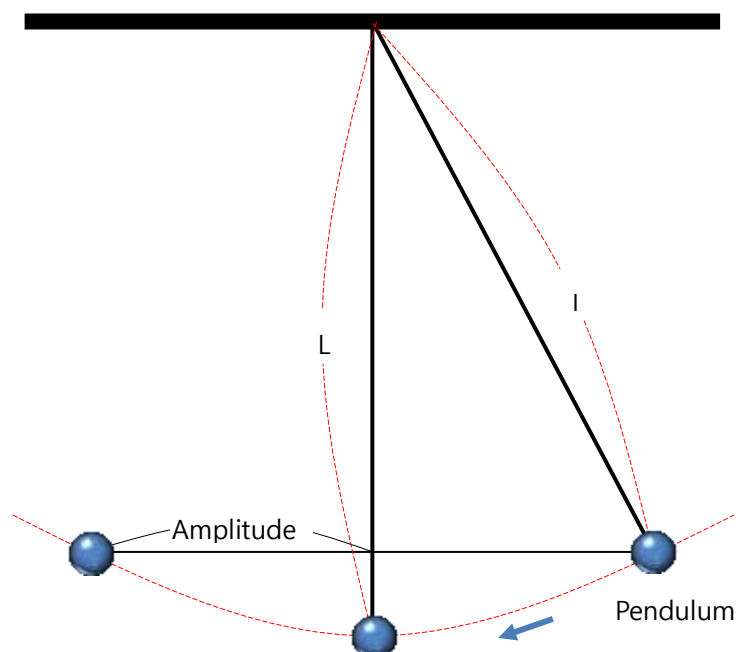2. **Calculate and explain gravitational acceleration using the pendulum period formula.**

Fundamental Concept

1. **Pendulum Period**

   The time it takes for a pendulum to complete one full oscillation.

2. **Pendulum Amplitude**

   The distance between the center of the pendulum and the point where the pendulum changes direction.

3. Isochronism of the Pendulum

The period of the pendulum is independent of the mass of the bob and the amplitude of the swing, but it increases with the length of the string

$$T = 2\pi\sqrt{\frac{L}{g}}$$ (T: period, L: length of string, g: gravitational acceleration)

Experiment

Materials Needed

Interface, Science# Program, photogate, string (70 cm), stand, weights (100g, 200g), photogate mounting rod, clamp, holders (2), measuring tape, clip.

Preparation of Experimental Apparatus

1. Attach 3 holders to the stand rod.
2. Install the photogate at the bottom of the stand using the mounting rod.
3. Secure the clamp to the top of the stand using a holder.
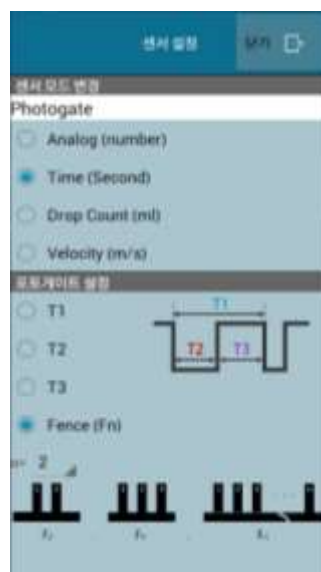

Amplitude
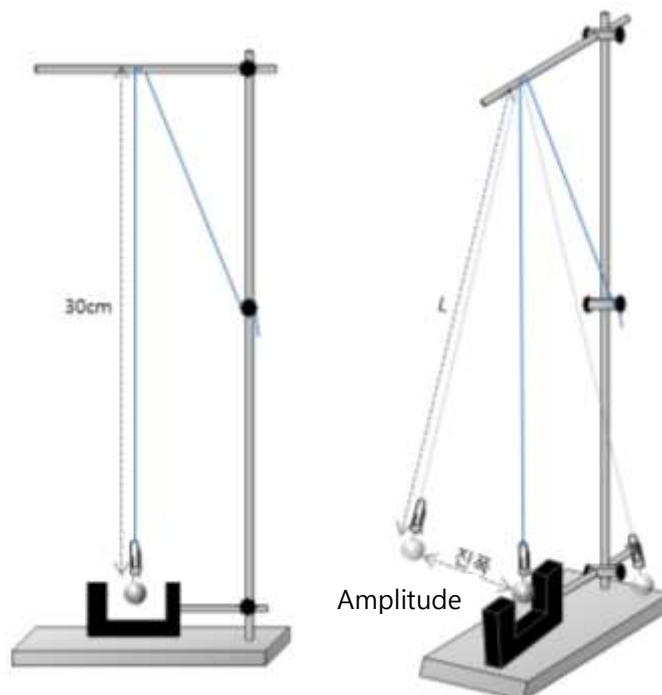
4. Tie a clip to one end of the string.

5. Wrap the string around the clamp so that the length of the string is 30 cm, and secure it with the middle holder.

6. Attach a 100g weight to the clip.

7. Adjust the height of the clamp so that the weight is centered in the photogate detection area.

photogate sensor area
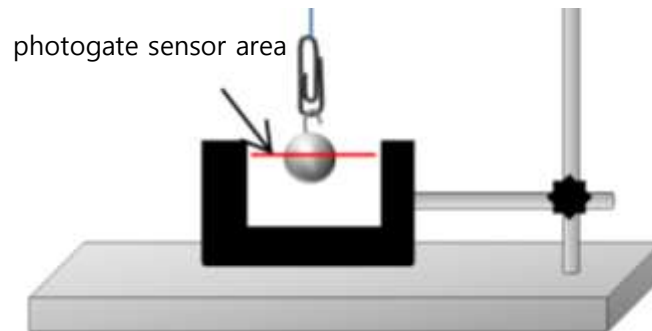
Interface Setup

1. Run the Science# program

2. Connect the photogate to the interface..

3. Click to set up the sensor as shown below.
   - Sensor Mode Change_ Time(second)
   - Photogate Setting_ Fence _ n=2

Data Collection

1. Slowly lift the weight to achieve an amplitude of 5 cm
2. Click ▶ to start data collection.
3. Release the weight and record the period of the pendulum as measured.
4. Measure the period of the pendulum while varying the length of the string, the mass of the weight, and the amplitude as follows.

< Experimental Conditions>

| Condition	String Length (cm)	Mass of Weight (g)	Amplitude (cm)
A	30	100	5
B	30	100	8
C	30	200	5
D	40	100	5

Data Analysis

Recording Data

1. Record the period of the pendulum based on the string length, mass of the weight, and amplitude

Condition	String Length (cm)	Mass of Weight (g)	Amplitude (cm)	Period (sec)
A	30	100	5	
B	30	100	**8**	
C	30	**200**	5	
D	**40**	100	5	

2. Explain the factors that determine the period of the pendulum.

Data Application and Extended Activities

1. The following images (a) to (d) show steel balls of different masses suspended by strings. Identify which one has the shortest period when swung with a small amplitude. (Assume larger balls have greater mass.)
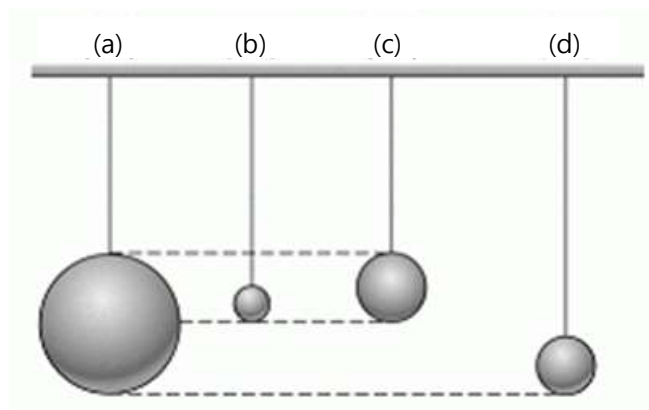
2. Grandfather clocks often had pendulum bobs. If the pendulum of such a clock takes 20 seconds to complete 10 oscillations, what is its period and frequency? Also, this clock tends to run slower in the summer. How can it be adjusted to keep accurate time?

3. Using the following pendulum period formula, derive the formula for gravitational acceleration and calculate it using actual experimental results.

$$T = 2\pi \sqrt{\frac{L}{g}}$$

Report
(For Teachers)

Report
(For Students)