Teacher packs in Experimental Science

PHY Pack 6

Verification of the Acceleration due to Gravity *g* by a Simple Pendulum

Pack contents:

A. Teacher's Guide
B. Students Guide
C. Assessment – Student's sheet
D. Extensions to experiment
E. Useful Links
F. Health and Safety
G. Evaluation of pack

Curriculum Areas Covered:

The universe
Forces
Physics Project.

Produced under a DelPHE-funded collaboration between the University of Cape Coast and The Open University, UK

Title: Determination of Acceleration due to Gravity, g, using a Simple Pendulum

Target group: Diploma in Basic Education

Also suitable for: B.Ed. Basic Education

Duration of Activity: 50 minutes plus discussion time

Learning outcomes: At the end of the lesson the student should be able to

1. Knowledge and Understanding (KN)	KN1	Explain simple harmonic motion.
	KN2	Explain the terms frequency, period, amplitude.
	KN3	Define the periodic motion.
	KN4	Give examples of periodic motion.
2. Cognitive Skills (CS)	CS1	Solve problems involving period and frequency.
	CS2	Give examples of periodic motion.
	CS3	Give practical applications of SHM.
	CS4	Explain the relationship between period and length of the pendulum.
	CS5	Explain the relationship between period and frequency of simple harmonic motion.
3. Key Skills (KS)	KS1	Solve problems involving period and frequency.
4. Practical Skills (PS)	PS1	Measure accurately and analyze data scientifically
	PS2	Draw a graph and interpret it scientifically
	PS3	Determine the acceleration due to gravity, *g*
	PS4	Present results/calculations as clearly as possible.

Curriculum areas covered:

The universe, Forces and Physics Project.

A. Teacher's Guide

Overview

Students are asked to setup an experiment to determine the acceleration due to gravity using a simple pendulum. Teachers should ensure that oscillations are well timed.

Aim

The experiment is to enable students to measure the acceleration due gravity using the simple pendulum.

Practical Skills developed

1. Setting up the experiment
2. Displacing the bob through small angles
3. Timing correctly twenty oscillations

Advice to Tutors

1. Encourage students to use different lengths of the pendulum.
2. Students should record their readings systematically i.e. in increasing and decreasing order.
3. Create time to discuss the physics about what is going on and to introduce the concept of gravity.
4. Discuss how the acceleration due to gravity varies from one part of the earth to another. Ask about the acceleration due to gravity on the moon. How does it compare to that of earth?
5. Go through the assessment questions with the students.

Sample Assessment Questions with answers

1. How does the measured g compare to the theoretical value of $g = 9.8 m s^{-2}$. (PS1)

   Answer: Answer can be obtained after performing the experiment.

2. If T is plotted against the square root of *l*, what will be the nature of the graph? (CS4)

   Answer: It will be a straight line passing through the origin with positive slope.

3. What is the relationship between frequency and period of oscillation? (CS5)

   Answer: Period = 1/ frequency

4. What is a simple harmonic motion? (KN1)

   Answer: It is a motion which repeats itself at regular intervals.

B. Student Guide

Purpose/Aim: To determine of the acceleration due to gravity g using simple pendulum

Background Information
The phenomenon of simple harmonic motion is being studied using a suspended pendulum to find the acceleration due to gravity.

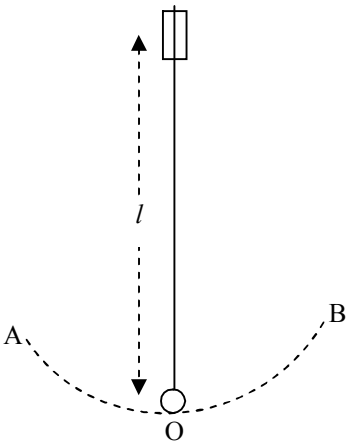

Figure 1 Length *l* of thread is increased or decreased systematically and the time for 20 complete oscillations measured.

The purpose of the experiment is to study the motion of a simple pendulum bob and to determine the acceleration due to gravity g. Any object on earth experiences acceleration due to gravity. If the length of the pendulum is l and g is the acceleration due to gravity at the place where the pendulum is used, then the time for one complete oscillation is given by

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

You are provided with a pendulum bob, retort stand and clamp, metre rule, stop watch, inextensible thread and a split cork. You are to set up the experiment as shown in the diagram above.

Equipment/ Materials/Apparatus
Inextensible thread, bob, stop-watch, meter rule, retort stand, coins.

Procedure
1. Suspend the spherical bob from the free end of the long thread hanging freely from a cork.
2. Set up a reference point at the equilibrium position of the bob. Measure the height, l of the bob from the cork.
3. Set the bob swinging through a small angle (about 5°) about the equilibrium position. Start the stop watch with a zero count about the equilibrium position and record the time for 20 complete oscillations. ($O \rightarrow A \rightarrow O \rightarrow B \rightarrow O$ is an example of 1 complete oscillation)
4. Repeat procedures 1 to 3 for the same length. Find the average time t. Calculate the period of oscillation T.

5. Repeat the procedure (steps 1 to 4) for 4 more different lengths of thread, *l*, using a constant interval between lengths.
6. Plot a graph of T^2 as ordinate against *l* as abscissa. Determine the slope of the straight line graph obtained and comment on the sign of its value. [Take $\pi = 22/7$]

recordings	*l*/cm	t_1/s (first set of readings)	t_2/s (second set of readings)	$t=(t_1+t_2)/2$	T/s=t/20	T^2/s^2
1						
2						
3						
4						
5						

C. Assessment – Student's sheet

On completion of the experiment, you should answer the following questions:

1. How does the measured g compare to the theoretical value of $g = 9.8 m s^{-2}$?

(PS1)

2. If T is plotted against the square root of *l,* what will be the nature of the graph?

(CS4)

3. What is the relationship between frequency and period of oscillation?

(CS5)

4. What is a simple harmonic motion? (KN1)

D. Extensions to experiment

Perform the experiment using a bob of different mass and comment on the value of g obtained.

E. References and Other Useful Links

1. http://www.mip.berkeley.edu/physics/physics.html

2. Abbot A. F. (1980), *Ordinary Level Physics*, 3rd Edition, Heinemann Books International, London.

F. Health and Safety

For large hanging masses put something on the floor to protect it should the mass fall.

G. Evaluation