Projekt współfinansowany w ramach programu Unii Europejskiej Erasmus+

Physics
Oscillatory motion

Topic	Mechanical vibrations
Duration	2 lessons (90 minutes)
Class/Age	The series is primarily intended for final years of primary school (years 7-8) and for years 1 or 2 of secondary school during the implementation of the core curriculum for physics (basic course). It can also be used to implement the core curriculum for advanced physics to describe harmonic motion.
Objective	**Main objective:** Understanding and describing oscillatory motion. **Specific objectives:** The student defines oscillatory motion and gives examples. The student describes the quantities characterising oscillatory motion: amplitude, period, frequency of vibrations, damping of vibrations. The student analyses oscillatory motion based on graphs. The student conducts experiments related to oscillatory motion using an EMPE sensor. The student draws conclusions from the experiments conducted.
Description	Students examine the oscillatory motion of a body (e.g. a board suspended on a string) using an EMPE sensor and software that displays a real-time graph of position changes as a function of time. During the lesson, students: • Set the body in vibratory motion and observe the graph of its position changes over time on the screen • Analyse the shape of the graph and recognise the characteristics of oscillatory motion (periodicity, amplitude, equilibrium position) • Compare graphs for different initial conditions (different amplitude, mass, pendulum length) • Interpret and analyse various graphs of oscillatory motion recognise errors and unusual cases
Teaching aids	- EMPE sensor with software - desktop computer or laptop with web browser - projector, projection screen or multimedia board

FIRST LESSON

I. Introduction (10 minutes)

1. Brief review of previous lessons on motion
(e.g. reference systems, relativity of motion, uniform motion, uniformly variable motion).

During the review, the teacher should encourage (but not force!) students with mild intellectual disabilities to speak. They should be asked questions to allow the teacher to ensure that they have mastered the content relevant to the rest of the lesson and to allow for any necessary reminders of important points and/or corrections of mistakes.

2. Introduction to the topic:

- Ask an introductory question:
  Have you ever encountered a movement that repeats itself?
  Where? In what situations have you observed such a movement?

- Give examples of oscillating movements from everyday life
  (e.g. swinging, heartbeat, guitar string vibration).
- Demonstrate oscillatory motion: set in motion an object (e.g. a small board) suspended on a string attached to a hook in the ceiling
  or suspended on a tripod.

During the demonstration, pupils with mild intellectual disabilities should be seated in such a way that they can observe the demonstration without obstruction.

- Explain that the lesson will focus on oscillatory motion and its description.

II. Theoretical introduction (10 minutes)

1. Explain the basic concepts used in the description of oscillatory motion in relation to the previous demonstration:

- Vibratory motion: motion that repeats at regular intervals.

- Equilibrium position: the point at which a body remains at rest when no external forces act on it.

- Amplitude: the maximum deviation of a body from its equilibrium position.

For pupils with mild intellectual disabilities, explaining the above issues should not be based solely on verbal methods. It will be necessary to supplement the theory with a demonstration.

III. Experiment with a motion sensor (15 minutes)

We use a pendulum specially prepared for this purpose, which has a flat wall, e.g. in the form of a board suspended on a string. We set the EMPE sensor so that it measures the amplitude of the board's deviation from its equilibrium position.

We can also use a long spring on which we hang a weight with a large base area, the changes in distance from the ground of which we will measure using the EMPE sensor.

During the demonstration, pupils with mild intellectual disabilities should be seated in the classroom in such a way that they can observe the demonstration without obstruction.

2. Demonstration:

The teacher demonstrates how the motion sensor works and how data is recorded.

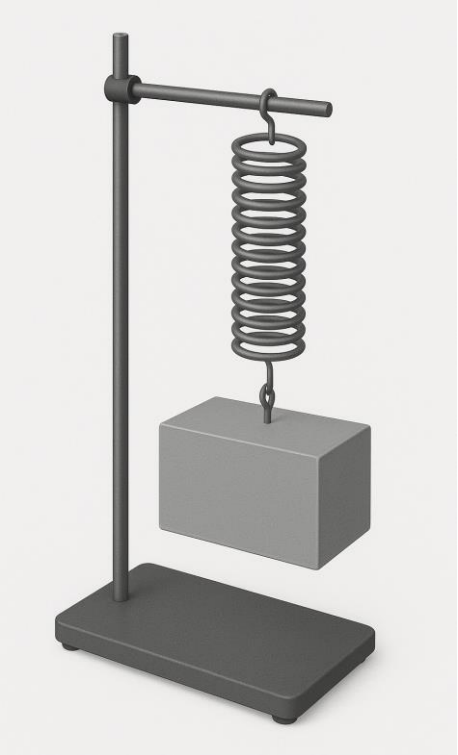
3. Conducting the experiment by students (group work):

If there is more than one student with mild intellectual disabilities in the class, they should not be placed in the same group. When working in groups, the teacher should pay attention to whether students with SEN are excluded by other group members from actively participating

in the experiment. Knowing the needs and abilities of the students, the teacher may suggest a specific role for the student with SEN, e.g. setting the pendulum in motion.

- Students set the pendulum in oscillatory motion.

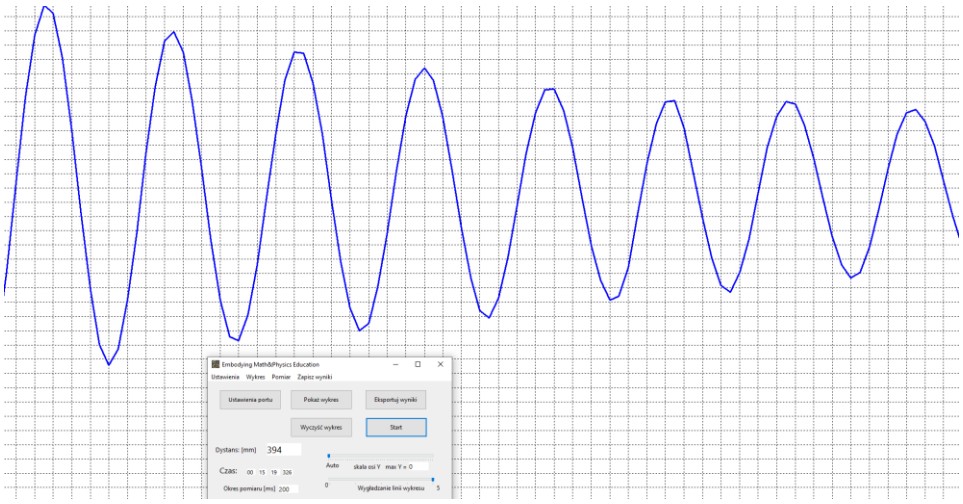
1. Preparing the workstation:
place the EMPE sensor
A) under the oscillating body suspended on a spring, remembering that the distance should be greater than 40 cm,



B) perpendicular to the surface of the board, remembering that the distance should be greater than 40 cm
due to the accuracy of the sensor measurement

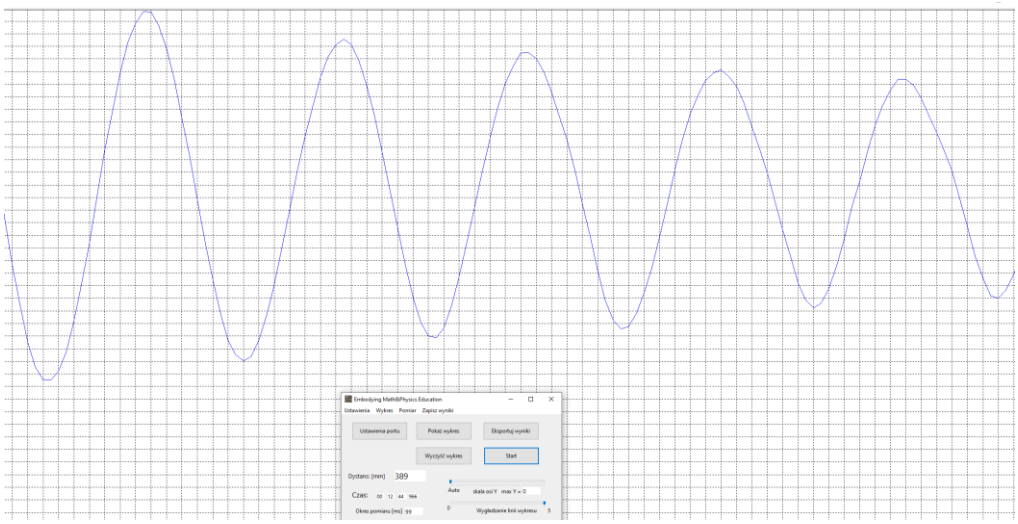
Fig. Pendulum setup (e.g. a board suspended on a string).

Connect the motion sensor to the computer and launch the software.
If you do not have access to a physics laboratory, you can use the EMPE kit, placing heavy objects in the case to increase its weight and repeating the experiment as shown in the photo. The case is suspended on a string with an adjustable length of 150-250 cm.

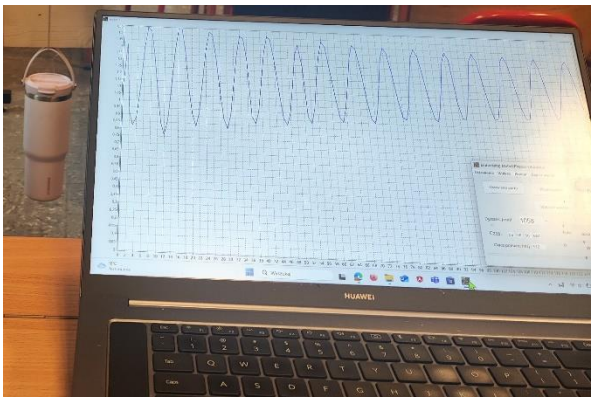


The recording frequency has a significant impact on the quality of the recorded data. We recommend setting the value to 100-150 [ms]. We recommend setting the sensor to measure distances of no less than 30 cm.

Sample recordings for a recording period of 200 ms and 100 ms (below).



The motion sensor records changes in body position over time.



- Students observe the graph on the computer screen.

For students with mild intellectual disabilities, the computer screen must be adapted to their perceptual abilities: image legibility, font size.

IV. Discussion (15 minutes), sample questions.

1. *How does the position of the body change over time? Is this movement repeatable?*
2. *Is it possible to read the time of one swing from the graph, and if so, how?*
3. *At which point on the graph is the body's deviation from the equilibrium point greatest,*
   and where is it smallest? What do we call these values?
4. *How can the amplitude of the movement be read from the graph?*
5. *Where on the graph is the body's equilibrium position? How can you recognise it?*
6. *What can you say about the time intervals between successive maximum deflections?*
7. *Are these times equal?*
8. *What would the graph look like if the amplitude of the movement was greater/smaller?*
9. *How would the shape of the graph change if we changed the mass of the oscillating body?*
10. *How would the shape of the graph change if we changed the length of the pendulum?*
11. *Do you observe any irregularities? What could be the cause of them?*

During the discussion, the teacher should encourage (but not force!) students with mild intellectual disabilities to participate actively. Students should be given the opportunity to speak and present their ideas. This will not only allow them to participate actively in the lesson, but also enable the teacher to ensure that students understand the content being taught and to correct any mistakes.

V. Homework assignment (5 minutes)

Task:
Find examples of oscillatory motion in your environment and describe them, giving approximate amplitude values.

Task for students with mild intellectual disabilities:

Find **two** examples of oscillatory motion in your surroundings. Describe these motions. Give approximate values for the amplitude of each of these motions.

Summary

During this lesson, students learned about one way of describing oscillatory motion – using graphs. The use of the EMPE sensor allowed for practical implementation of the description in real time and greater understanding and analysis of this phenomenon. Active participation in the experiment and discussion should reinforce the knowledge gained and develop the ability to analyse experimental data.

Ensure that students with mild intellectual disabilities have properly recorded notes from the lesson.