

## **Lesson Plan on Physics**

**Topic: Movement of the pendulum.**

**Teacher: Ms Karolina Górska**

**Time: 2x45 min**

**Students:**

- Describe the movement of the pendulum
- Use the notion of amplitude of vibrations, period and the frequency in order to describe the vibrations,
- Point the position of balance as well as read the amplitude and period from the chart  $x(t)$  for the vibrating body,
- Mark the period and frequency of vibrations of the pendulum.

**Methods:**

- oral,
- observations,
- practical

**Forms:**

- group work,
- individual work.

**Teaching aids:**

- inextensible thread,
- weights,
- timer,
- ruler,
- interactive whiteboard,

**Lesson course**

➤ **Introduction:**

*Taking the register, checking the homework.*

Teacher asks students about the example of phenomenon which regularly occur in their everyday surroundings.

Students enumerate: vibration of guitar strings, human heart vibration, vibration of atoms inside the substance etc.

Teacher explains certain notions:

- Pendulum,
- Vibration
- Oscillating motion
- Period of vibration
- Frequency
- Amplitude of vibrations

➤ **Realization:**

**I. The first part**

In order to introduce the topic and remind the previous subject of oscillating movement teacher uses a text from a book *Opowieści z historii fizyki (Stories from the history of physics)* by Andrzej Drzewińskiego and Jacek Wojtkiewicz. There is a story of Galileo who uses his own pulse in order to measure time. What's more, he discovers that duration of vibration of pendulum depends on the length of the rope.

**II. The second part – experimental**

**Teacher divides class into teams. Each team carries out the experiment according to the instructions. In order to make sure groups work on their own, they work on the school playground. The group which finishes first get a good mark (5)**

Marking the period of vibration of the pendulum and checking if the period and frequency depend on the amplitude of vibrations

Teacher explains issues concerning the experiments.

- **Which variable is going to be changed? (independent variable)?**
  - Deflection of the pendulum.
- **Which variable is going to be measured - observed? (dependent variable)?**
  - Time of the vibration 10 full vibrations of the pendulum
- **What is not going to be changed in our experiment? (control variable)?**
  - Mass of the pendulum.

**EXPERIMENT 1 – MARKING THE PERIOD AND FREQUENCY OF VIBRATIONS**

Device and materials: pendulum length about 2 m, timer

1. Incline the pendulum from the position of balance by a small angle and observe the movement of the weight. Pay attention to repeatability of movement and changes of amplitude. Why does the amplitude change? .....
2. Measure the duration of 10 full vibrations. Repeat the measurement twice (for different but also small angles). Complete the chart.
3. Calculate period of vibration of the pendulum and measurement uncertainty of period of vibrations for each from the three measurements. Complete the chart
4. Calculate the frequency of vibrations. Complete the chart.

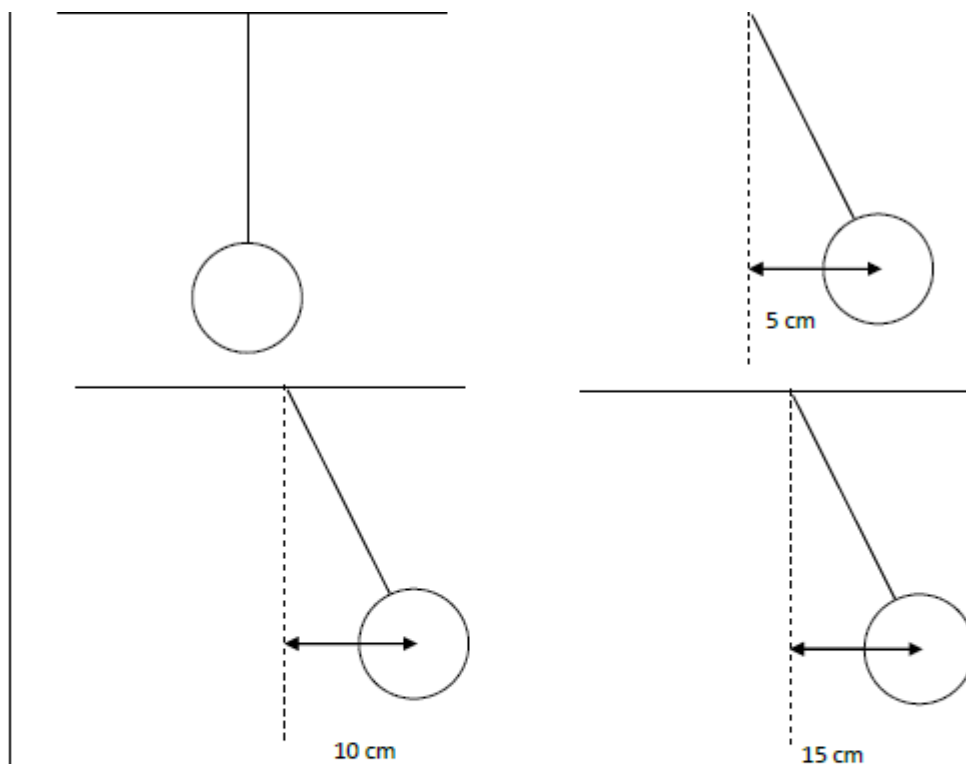
|                                |   |   |   |
|--------------------------------|---|---|---|
| Number of measurement          | 1 | 2 | 3 |
| Duration 10 vibrations<br>t(s) |   |   |   |
| Period T(s)                    |   |   |   |
| Frequency f(Hz)                |   |   |   |

5. The angle of deflection is different at each measurement. Has the period of vibrations changed? What is that feature called?

## EXPERIMENT 2 – CHECKING IF THE PERIOD AND FREQUENCY DEPEND ON THE AMPLITUDE OF VIBRATIONS

Device and materials: weight 50g, inextensible thread 1m, timer, ruler.

1. Tie the thread to the weight and hang the pendulum in a suitable place (so it can move freely)
2. Incline the pendulum for 5 cm from the position of balance and let it go.
3. With the timer, measure the duration of 10 full vibration three times. Calculate the average time and write the result in the chart. Then, calculate the period of vibrations.
4. Repeat the experiment. But now, incline the pendulum for 10cm and 15 cm. Write the results in the chart.
5. Calculate the period of vibrations for each incline.



| Amplituda<br>(cm) | t              |                |                |                 | T | f |
|-------------------|----------------|----------------|----------------|-----------------|---|---|
|                   | t <sub>1</sub> | t <sub>2</sub> | t <sub>3</sub> | t <sub>sr</sub> |   |   |
| 5                 |                |                |                |                 |   |   |
| 10                |                |                |                |                 |   |   |
| 15                |                |                |                |                 |   |   |

### Conclusion:

Period and frequency of vibrations of the pendulum at small angles don't depend on amplitude of vibrations. - **ISOCHRONISM OF PENDULUM**

### **EXPERIMENT 3 - CHECKING IF THE PERIOD AND FREQUENCY DEPEND ON THE LENGTH OF THE PENDULUM:**

1. Prepare timer, two beads of the same mass, hang them on the threads  $l=50\text{cm}$  and  $l=200\text{cm}$ .
2. Hang the pendulums on a support stand.
3. Incline the beads at a small angle from the position of balance and measure 10 full oscillation.
4. Write the results in the chart and calculate the period of vibrations.

| Length of the pendulum $l$ (cm) | Number of vibrations $n$ | Duration $n$ of vibrations $t_1(\text{s})$ | Duration $n$ of vibrations $t_2(\text{s})$ | Duration $n$ of vibrations $t_3(\text{s})$ | The average duration $n$ of vibrations $t_{\text{sr}}(\text{s})$ | Period of vibrations $T$ (s) | Frequency of vibrations $f$ [Hz] |
|---------------------------------|--------------------------|--------------------------------------------|--------------------------------------------|--------------------------------------------|------------------------------------------------------------------|------------------------------|----------------------------------|
| 50                              |                          |                                            |                                            |                                            |                                                                  |                              |                                  |
| 200                             |                          |                                            |                                            |                                            |                                                                  |                              |                                  |

### **Conclusions:**

Period of vibrations depends on the length of the pendulum.

The long pendulum has a longer period of vibrations than the shorter one.

You can compare the movement of the pendulums of different length to the movement of legs.

### **III. The third part – solving calculative exercises**

#### **Ex. 1.**

A ball, hung on a thread, does 30 vibrations in time  $t=60\text{s}$ . What is the period and frequency of vibrations of the ball?

#### **Ex. 2.**

During time  $t=2\text{ min}$  a swing has done 60 full oscillations. What is the period of vibrations of the swing?

#### **Ex.3**

An experiment determining the period and frequency of vibrations of the pendulum with length of 1,5 m has been carried out. The chart presents the results of four measurements duration of 15 full vibrations of the pendulum.

| Lp.    | 1.   | 2.   | 3.   | 4.   |
|--------|------|------|------|------|
| $t(s)$ | 36,7 | 36,9 | 36,4 | 36,2 |

1. The average time of 15 full vibrations is  $t_{av} = \dots\dots\dots$
2. Period of vibrations of the pendulum on the basis of measurements is  $T = \dots\dots\dots$
3. Period of vibrations rounded to two numbers is  $T_{rounded} = \dots\dots\dots$
4. Frequency of vibrations of the pendulum rounded to two numbers is  $f = \dots\dots\dots$

#### IV. The fourth part - Summing-up

<https://learningapps.org/919719>

<https://learningapps.org/display?v=p7oyrhw2j18>

#### V. Homework

1. Give examples of objects from our everyday surroundings which do movement similar to the movement of the pendulum.





