Demonstrator # 22

Elastic Pendulum

Teacher notes

Activity title:

Oscillating motion

Theme:

Study of the elastic pendulum

Student age:

17 years

Estimated time:

100 min

Scientific content

gives needed science background (concepts, definitions, laws etc) including pre-requisite knowledge required and science concepts developed in the activity, includes relevant students' difficulties,

Concepts: period, frequency, gravitational acceleration, elastic constant, oscillation, graphical representation, dependent variable/independent variable;
Basic and development skills: observation, variables identification, graphic representation, register and interpret the significance of measured/registered data

Learning Objectives

At the end of the lesson the pupils will be able to:

- define and characterize the oscilation motion and its characteristic physical quantities;
- establish the cauzes and effects;
- use elements of digital system for registring data for different dynamics experiments specific respecting the role of the main components of such a system;
- investigate properties of different physical systems using the InLot system, the virtual instrumentation designed in such a way to facilitate the comand of a data aquisition device

Character of inquiry based activity

highlights the IBSE character of the activity, specifies a type of inquiry and lists inquiry-based skills (for details, definitions and terminology to use see 'Short guide for designing inquiry-based teaching materials')
Guided investigation; Blended investigation
Teacher guided discovery

Applied technology (if necessary)

Materials needed

- movie sequence showing a child or younster on a swinging play, computer, videoprojector, elastic pendulum, gravitational pendulum, experimental activity sheet

Methodical guide

describes method, student learning activities (discussions, investigations, data analysis, reflections etc.) and leading questions, includes a suggested time outline

Anticipation

- **5 minutes essay** – pupils write for 5 min a short text using the words given by the teacher: vibrate, motion, deformation, time, meaure. Then 4 or 5 ”essays”, of the students who want to or offer to read and the teacher together with the other pupils check if all the words hsve been used and offer feedback.

Building knowledge

- Teacher ask pupils to carefully watch a movie sequence and to identify and define the type of the observed motion.
- Pupils are organized in groupes of four, each group has the needed materials from the physics kit in order to realize the specific settings for the study of elastic pendulum together with copies of a scientific article (abot 1 page length). In this configuration pupils read the text and accomplish the experiments described in the experimental activity worksheet, fixing on each pendulum, one after other, the accelerometer and registering their own data.
- The Jigsaw methode: Each pupil recieve an experimental activity worksheet with the following tasks:
    - to realize the experiments with the elastic pendulum;
    - to interpret the graphics obtained by mean of using the accelerometer;
    - to describe and compare oscillating motion graph;
    - to realize a poster in which they should present the summary/scheme/squetch of activities, results and descovered explanations.

After about 15 min activity in the home group of four the teacher ask the pupils to count inside the groupe. All the pupils having number 1 goes together; the pupil with number 2 goes together, and so on, in such a way that, at the end, in the new setting all members come from different groups. In this new setting, named expert groups the pupils have to solve one of the tasks and fill in on the working sheet This secquence take about 20 min, time during which the teacher monitor the quality of discussions between the pupils, their focus on the investigated subject, the relevance, pertinence and acuracy of the scientific language and approach. The final step, pupils come back to their initial places – home groups – where they share their impressions, information, explanations learned/discovered in the previous sequence and they have about 10 min more in order to finalize and present/expoze the poster with the results they obtained together with the corresponding arguments**.**

Reflection/Consolidation

- **Assessment methode**: galery *tour* – the groups of four pupils expose the A3 paper sheets on which they synthetizeied the common negociated answers; each group receive a number of paper sheets (post-it) equal with the number of exposed posters, except for their own poster and they read the conclusions of their colleagues and after that they write down a question for each group. As a function of the time remaind, it is possible that each group to answer in classroom at all the questions that they received or every group take its questions and solves them as homework.
- **Evaluation instruments:** worksheets fill in; the classroom map/observation grid for the group activities

Assessment

provides suggestions how to asses the activity, preferable with concrete questions and expected student answers

⇒ Observation of group activities;
⇒ oral, conversation;
⇒ written ending sheets.

STUDENT WORKSHEET

Activity title:

Oscillation motion

Introduction

states a driving (research) question and outlines objectives
Experimental activity scope:

- determining the oscillation period for an elastic pendulum/gravitational pendulum by means of 3 different methods, identification of advantages/disadvantages and applicability limits for each method.

Thinking about the question

if needed provides information about the science addressed

Materials needed

- elastic pendulum
- chronometer
- different disks with marked mass
- accelerometer
- PC with InLOT soft

If needed lists warnings and cautions concerning the investigation

Investigation

Depending on the type of inquiry involved provides guidance on how to carry out the investigation
Measure the time interval (t) during which occurred n oscillations (10, 15, respectively 20).

Determine the period of oscillation of the pendulum by means of the relationship: $T_e = \frac{t}{n}$.

Write the data obtained in the table with experimental data and calculate the average value for the period with the formula: $\overline{T}_e = \frac{T_1 + T_2 + T_3}{3}$.

- measure the mass (m) of the pendulum (tija +mass marked discs)
- put the mass marked discs at the end of the elastic spring and measure, at equilibrium the length of the spring (Δl)
- calculate the elastic constant of the spring using the formula: $k = \frac{mg}{\Delta l}$, (g = 9,8 m/s^2),
- calculate the oscillation period with the formula: $T_c = 2\pi\sqrt{\frac{m}{k}}$
- write down the value such obtained in the table with the experimental data.

M3: - fix the accelerometer to the elastic pendulum;
- using the tutorial of InLOT determine the oscillation period of the pendulum (measure the time interval between n maxima and divide by n)

- write down the value such obtained in the table with the experimental data.

Analysis

If needed suggests analysis that can help interpret data

Table with experimental data:

Elastic pendulum											
M1					M2				M3		
nr. ms.	t (s)	n	T_e (s)	$\overline{T}_e$ **(s)**	m (kg)	Δl (m)	k (N/m)	**T_c (s)**	t (s)	n	**T_a (s)**
1.											
2.											
3.											

Further investigation

If needed provides suggestions for a next possible investigation or additional, deeper investigations

Assessment

If needed includes student assessment

Interpretation of the obtained results (advantages/disadvantages, applicability limits specific for each method):
Errors sources:
Suggestions for further use of InLOT system: