

Physics of earthquakes – basic package

Guide with lesson plans

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Physics of earthquakes – basic package

Guide with lesson plans

Package „Physics of earthquakes” is dedicated to work with students aged 13-15. It is recommended to be used during Geography and Physics classes.

Physics: package refers to the following points in the physics’ curriculum for primary school, grades 4-8 (content is very similar for lower secondary school):

Student:

- describes propagation of mechanical waves as a process of transferring energy without transferring matter; uses the concept of wave propagation speed;
- uses the concept of amplitude, period, frequency and wavelength to describe waves, and applies the relationships between these quantities and their units for performing calculations;

Through the use of presented materials during physics classes, students will be able to pursue general education goals, in particular:

- usage of concepts and physical quantities to describe phenomena and their examples in the surrounding reality;
- solving problems using physical laws and dependencies;
- usage of information derived from the analysis of source material, including popular science texts.

Geography: package enables the achievement of the general learning objectives set out in the curriculum for primary school, grades 5-8 or lower secondary school:

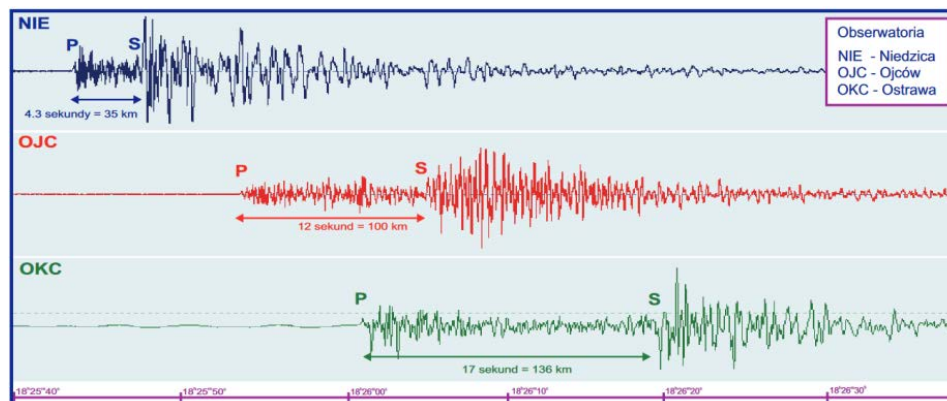
Student:

- identifies the relation between plate tectonic boundaries and the occurrence of tectonic ditches, volcanoes, earthquakes and tsunamis, and formulates theorems about the observed regularities in their distribution;
- describes ways to prevent the tragic consequences of earthquakes and tsunamis.

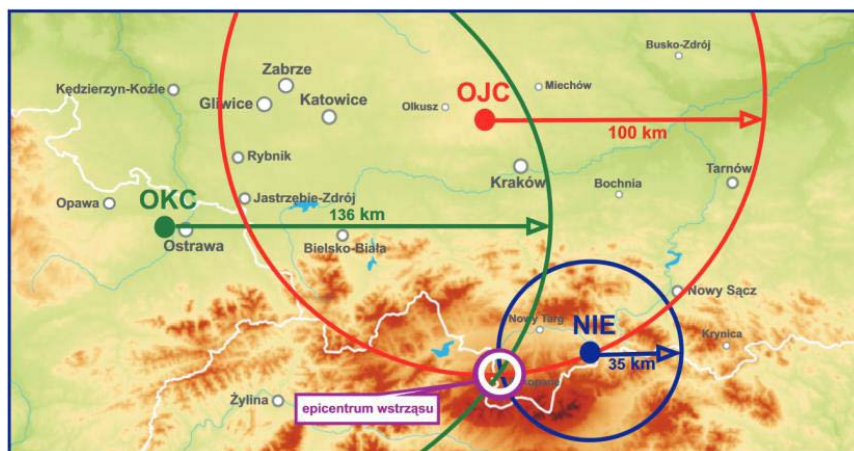
Title	Physics of earthquakes – basic package
Author	Dr. Łukasz Rudziński Department of Seismology Institute of Geophysics, Polish Academy of Sciences
Students’ age	13-15
Educational stage	Lower secondary school / primary school, grades: 7-8
Subject	Geography, Physics

Overview of package content

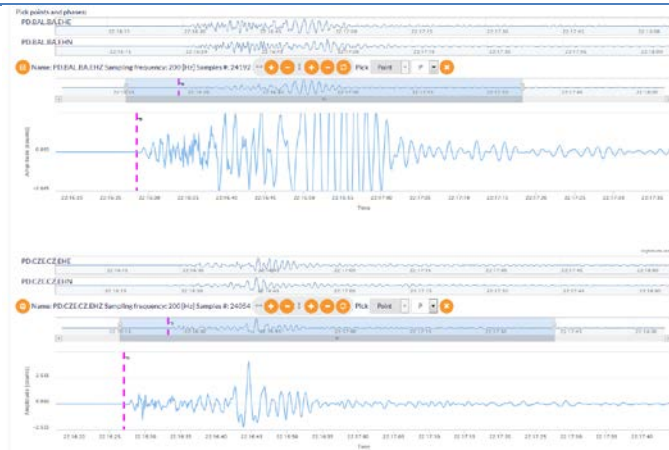
Seismology is a multidisciplinary science using knowledge from other disciplines, such as: geology, tectonics, physic and mathematic. The biggest challenge for seismologists is to elaborate earthquakes forecasting algorithm. Forecasting earthquakes means estimate time, location and strength of earthquakes with enough accuracy. Is it ever possible?



Despite many years of seismological studies all around the world, earthquakes forecasting algorithm has not been discovered. Nevertheless, using more and more sophisticated seismological studies, we believe that such algorithm will be available in the future.



Package „Physics of earthquakes” presents basis of seismology, its observations and measurements. It is also an introduction to the world of seismological observations thanks to the use of modern interactive seismological Platform: *Platform for Anthropogenic Seismicity Research* (<https://tcs.ah-epos.eu/>). It allows an analysis of real seismic signals recorded on real seismic networks.



At least several earthquakes occur every day. Usually the source of tremor is rock movement. Earthquakes can also be associated with volcanism and even can be triggered or induced by human activity. All of them are continuously monitored by very sensible devices called seismometers. Some of them are dedicated to record local and very small tremors which are not felt by human, while another observe strong earthquakes that occurs on the other part of the Earth. Seismometers record seismic waves which are next analyzed by seismologists using sophisticated software and knowledge of Earth structures. Thanks to that we are able to define origin time and location of source as well as strength of quakes and its mechanisms. Further studies describe seismic hazard on specific areas.



All this information is essential to understand how earthquakes happen.

Expected educational goals

Student knows:

- What seismology is and what it investigates;
- Terms: earthquake, epicentre, seismic wave, seismogram;
- How and where earthquakes occur;
- If earthquakes can be predicted.

Student understands:

- Relation between seismology, tectonics of the earth and construction of planet's interior;
- Why earthquakes occur more often in some places than in other
- The importance of seismology for society

Student can:

- Identify possible sources of earthquakes;
- Find first seismic wave onset;

Content of the package

1. „Physics of earthquakes” – presentation – basic package;
2. [„Physics of earthquakes” – basic package – movie based on presentation](#);
3. „Physics of earthquakes” – worksheet;
4. [„Physics of earthquakes” – Normal fault – animation](#);
5. [„Physics of earthquakes” – Reverse fault – animation](#);
6. [„Physics of earthquakes” - Strike-slip fault – animation](#);
7. „Physics of earthquakes” – Test;
8. „Physics of earthquakes” – Test – answers;
9. „Physics of earthquakes” – Guide with lesson plans.

Additional materials

- Seismic data from IS-EPOS Platform: <https://tcs.ah-epos.eu>
- Link to online test:
<https://play.kahoot.it/#/?quizId=5dc053-a855-46ab-9762-ebbdeaae7f53>

Lesson 1.

Subject: When the Earth shakes

Lesson plan for „Physics of earthquakes – basic”

In order to conduct the lesson, it will be necessary to provide:

- A multimedia projector, computer, speakers;
- “Physics of earthquakes” worksheet (no. 3)¹ printed for each student;
- wall map – physical map of the world;
- geographic atlas – tectonic map;
- smartphone with installed seismometer application (e.g. Hamm Seismograph).

Expected educational goals of the lesson:

The goals of the lesson are the same as the goals of the educational "Earthquake Physics - basic package."

Suggested forms of work:

- offering: a lecture, a talk;
- displaying: a presentation, a movie;
- activating: a discussion, a brainstorm;
- practical: exercises based on worksheets.

Lesson procedure:

1. Start of the lesson, organizational activities, attendance list check.
2. Introduction to the topic. The teacher asks questions, and encourages students to participate in the discussion about earthquake's (brainstorm).
 - Where did the earthquakes occur?
 - How often do we hear news about tragic earthquakes?
 - How do earthquakes affect people and nature?
3. With the use of physical map of the world students search for mentioned places. After that they compare it with the map in the geographic atlas (map of tectonic plates). Students should note that seismic activity (as well as volcanic activity) are related to the boundaries of lithospheric plates. There is no need for detailed discussion on the motion of the plates and the mechanism of this movement.
4. Students watch the movie "Physics of earthquakes" – basic package (no. 2). In this film, a researcher from the Department of Seismology of the Institute of Geophysics, Polish Academy of Sciences, Dr. Łukasz Rudziński discusses the phenomena associated with earthquakes. Optionally, these phenomena can be discussed by the teacher using the multimedia presentation (no. 1), so that it will be possible to adjust the level of difficulty to the age of the students. In the second case, the film can be used by the teacher to prepare for the lesson.

¹ Numbers of materials refer to the numbering in the table under „Content of the package”

5. After the movie, teacher distributes the worksheet „Physics of earthquakes” (no. 3). Students fill the worksheets on their own, teacher supervise the exercise.
6. Thanks to the movie students learned that most smartphones are equipped with accelerometer, so that after installing simple and free applications, they can see how the earthquakes are being recorded. Presented, as an example, application (Hamm seismograph) shows continuous registration of three components (x, y, z). By hitting gently in phone case, we can easily notice that each recording is responsible for different direction of movement:
 - vertical movements (up – down);
 - horizontal movements (east – west);
 - horizontal movements (north – south).

Thanks to the application, students can easily understand how measurements are taken and why in the past three different seismometers were installed to take measurements. Nowadays, one small device records all three components simultaneously.

7. Summary of the lesson. Students take the test. It may be a traditional test (no. 7), but it is recommended to use the online quiz using the kahoot.it website. Link to the test dedicated to the package:

<https://play.kahoot.it/#/?quizId=5dcdc053-a855-46ab-9762-ebbdeaae7f53>