

# Earth's magnetic field – extended package

## Guide with lesson plans

Download educational materials described in this guide from:

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## Earth's magnetic field – extended package

### Guide with lesson plans

Educational package „Earth's magnetic field – extended package” is dedicated for students aged 16-19. The ERIS educational package can be used during lessons carried out as part of the core curriculum, in particular in classes with extended Geography or Physics.

**Physics:** Package refers to the following points in the Physics curriculum for upper secondary schools:

Student:

- 1) outlines the course of magnetic field lines near permanent magnets and conductors with current (linear guide, loop, coil);
- 2) describes the influence of materials on the magnetic field;
- 3) describes the use of ferromagnetic materials;

**Geography:** Package refers to the following points in the Geography curriculum for upper secondary schools:

Student:

- 1) interprets geographical phenomena presented in diagrams, tables and models;
- 2) forms the cause and effect relationship, functional and temporal relationships between selected elements of the natural and socio-economic environment and verify them using thematic maps;
- 3) describes the mineralogical composition of the Earth's crust, the main groups and types of rocks and their economic application, and assesses changes in the natural environment related to the exploitation of mineral resources;
- 4) characterizes the most important geological and natural events in the history of the Earth (folds, continental drift, transgression and regressions of the sea, glaciation, development of the organic world);

The ERIS educational package can be used both during lessons carried out as part of the core curriculum and during extra-curricular activities.

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|---------------|----------------------------------------------------------------------------------------------------------|
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| <b>Students' age</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 16-19 years old                           |
| <b>Educational level</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Upper secondary school, technical schools |
| <b>Subject</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Physics, Geography                        |
| <b>Overview of package content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                           |
| <p>Thanks to this package, students will be able to answer questions regarding the influence of geomagnetism on life on planet Earth. Students will learn what the Earth's magnetic field is, will define its sources, where the magnetic poles are and discover what actually tourist compass shows and under what conditions it shows failed measurements. Students will get acquainted with the term "magnetic declination" and learn how to calculate declination in a given year on the basis of available data from geomagnetic observatories.</p> <p>Calculations will be based, among others, on data from INTERMAGNET, an organization of geomagnetic observatories around the world. Students will also learn how to find the maximum and minimum value of the magnetic declination of the day basing on charts; set a declination for a given date and place; determine the difference between the determined declination from real measurements and the declination derived from the model obtained from the declination calculator.</p> |                                           |
| <b>Expected educational goals</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                           |
| <p><b><u>Student knows:</u></b></p> <ul style="list-style-type: none"> <li>• Terms: earth's magnetic field, geomagnetism, magnetosphere, solar wind, magnetic storm, magnetic declination;</li> <li>• What is the source of earth's magnetic field</li> </ul> <p><b><u>Student understands:</u></b></p> <ul style="list-style-type: none"> <li>• Where earth's magnetic field comes from;</li> <li>• Difference between magnetic poles and geographical poles;</li> <li>• The influence of the Sun on earth's magnetic field</li> </ul> <p><b><u>Student can:</u></b></p> <ul style="list-style-type: none"> <li>• Explain where earth's magnetic field comes from</li> <li>• set geographic directions using a compass - taking into account the current magnetic declination</li> </ul>                                                                                                                                                                                                                                                            |                                           |
| <b>Content of the package</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                           |
| <ol style="list-style-type: none"> <li>1. "Earth's magnetic field" - presentation – extended package;</li> <li>2a. <a href="#">"Earth's magnetic field" - movie based on the presentation;</a></li> <li>2b. <a href="#">"Earth's magnetic field" - movie with the short summary;</a></li> <li>3. "Earth's magnetic field" – worksheet "What do the compasses really indicate?";</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                           |

4. "Earth's magnetic field" – worksheet "Calculation of declination";
5. "Earth's magnetic field" – Instruction to worksheet "Calculation of declination";
6. "Earth's magnetic field" – How to use geomagnetic data from the INTERMAGNET network;
7. "Earth's magnetic field" – Quiz;
8. "Earth's magnetic field" – Quiz with answers;
9. "Earth's magnetic field" – methodological guide with lesson plans.

#### **Additional materials**

- <http://www.ngdc.noaa.gov/geomag-web/> - access to the INTERMAGNET platform offering data from geomagnetic observatories;
- <http://www.intermagnet.org/data-donnee/dataplot-eng.php> - link to the magnetic declination calculator based on the WMM or IGRF model.
- Link to the online test:

<https://play.kahoot.it/#/?quizId=5cc4631f-9921-42a2-9bbb-64eb70df5466>

## Lesson 1.

### Subject: What do the compasses really indicate?

Lesson plan for „What do the compasses really indicate?– extended package”.

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

- compasses, magnet (various types), coil + battery for demonstrating the flow of electric current, filings of iron, white card;
- multimedia projector, computer, speakers;
- multimedia presentation "Earth's magnetic field" – presentation – extended" (No. 1)<sup>1</sup>

Expected educational goals of the lesson:

The goals of the lesson are the same as of the educational "Earth's magnetic field" – extended 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. As introduction of the lesson, teacher, accompanied by students, will perform several demonstrations.

#### Demonstration 1. How is a compass built?

The teacher provides students with compasses. Students check that all compasses indicate the same directions. In the case of differences, students wonder about the causes of differences. The teacher asks students to describe how a compass is built.

#### Demonstration 2. Co What interferes with the compass?

The teacher presents to students how various items that affect the magnet's display: a piece of steel, an aluminum plate, a copper bar, a magnet and a coil through which electric current flows. Students draw conclusions that the magnet is indicated by the influence of: iron (steel is an alloy of iron and coal), magnet, coil with electric current.

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<sup>1</sup> Numbers of materials refer to the numbering in the table under „Content of the package”

## Experiment 1. Magnetic field lines

The teacher informs students that a magnet suspended freely, which will be in the magnetic field, is positioned along the magnetic field lines. Magnetic field lines are invisible to us, but we can observe them indirectly.

For the experiment you need a bar magnet, iron filings, a white card (e.g. A4). Students cover the magnet with a white sheet and they gently sprinkle it with iron filings. The iron filings are arranged in such a way that the lines of the magnetic field are visible. Students draw in the notebooks the lines of the magnetic field around the bar magnet.

The teacher informs students that the Earth behaves like a huge magnet and magnetic field lines run around the Earth. That's why the magnetic needle points north.

3. Teacher presents the presentation "Earth's magnetic field" – extended (No. 1). In order to be prepared for the lesson, we recommend watching [the film "Earth's magnetic field"](#) (No. 2a), in which the author discusses the presentation and indicates the most important information about the Earth's magnetic field. During the presentation the author refers to the demonstrations and experiments performed by the students in the first part of the lesson. You may also watch a short summary video (No. 2b).
4. Summary of the lesson. Students perform the test. It may have the character of a traditional test (No. 7), but it is recommended to use the online quiz using the kahoot.it website. Link to the test:

<https://play.kahoot.it/#/?quizId=5cc4631f-9921-42a2-9bbb-64eb70df5466>

## Lesson 2.

### Subject: In the pursuit of magnetic poles.

Lesson plan for 'In the pursuit of magnetic poles – extended'.

Lesson 'In the pursuit of magnetic poles – extended' is planned as continuation of the lesson 'What do the compasses really indicate?', which contains information and skills necessary for the proper performance of tasks.

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

- multimedia projector, computer, speakers;
- multimedia presentation "Earth's magnetic field" – extended package (no. 1)
- worksheets printed for each student: „Calculation of declination" (no. 4) and instruction to this worksheet (no. 5);
- school accessories (ruler, pencil);

Expected educational goals of the lesson:

The goals of the lesson are the same as of the educational 'Earth's magnetic field – extended package'.

Suggested forms of work:

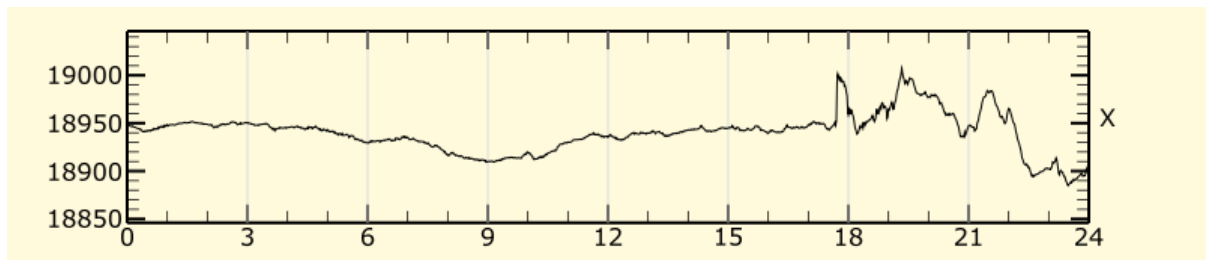
1. offering: a lecture, a talk;
2. displaying: a presentation, a movie;
3. activating: a discussion, a brainstorm;
4. practical: exercises based on work sheets.

Lesson procedure:

1. Start of the lesson, organizational activities, attendance list check.
2. The teacher reminds students what a magnetic declination is. He/ she points out that the value of declination is different in different places on the globe, and also changes over time. As a reminder the multimedia presentation "Earth's magnetic field" – extended (no. 1) - slides 16. – 18 can be used.
3. The teacher provides students with "Calculation of declination" instructions to worksheet (no. 5) and explains how actual declination value is calculated based on the data read from the map. Students together with the teacher analyze the examples given in the instruction.
4. The teacher provides students with the "Calculation of declination" worksheet (No. 4). Students solve the task 1. The chosen student solves the tasks on the board, the other students check the correctness of the task.

5. Students carry out the task 2 by themselves. After a few minutes, students compare their answers with each other. The teacher explains the differences and answers students' questions.
6. The teacher informs students that Polish scientists are constantly conducting research in the field of magnetic field. These observations are made in two observatories in Poland (Belsk and Hel) and in the Polish Polar Station Hornsund in Spitsbergen. The geomagnetic observatories are marked with a black dot on the map dedicated to task no.3. The name of the station and its geographical coordinates are marked on the magnetograms attached to the task. Students analyze geographical coordinates and write the station names on the map.
7. The teacher explains how data from measurements of the Earth's magnetic field are recorded. The recording of such a measurement is called a magnetogram. In the example below, we can see that the hours from 0.00 to 24.00 are marked on the horizontal axis. On the vertical axis are the recorded value of the magnetic field - the values are given in nanotesla (nT). Students perform task 3 in the worksheet. The task is to calculate the daily difference (amplitude) of the magnetic field strength. Students enter calculated value and conclusion on the dependence of the amplitude of the magnetic field on the latitude on the map next to the name of each station.

**1 Magnetogram for Belsk, 3 August 2010, Geographic coordinates:  $\phi=51^{\circ}50.2' N$ ,  $\lambda=20^{\circ}47.5' E$**



8. At the end of the lesson students perform task 4 from the worksheet, related to tracing the movement of the northern magnetic pole. On the basis of the data from the table, students draw the pole position in the years 1995 - 2015. Then, they estimate where the pole is most likely to be found in 2020 and 2030.
9. Teacher summarizes the lesson and answers to possible questions.

## Lesson 3.

### Subject: How to use geomagnetic data from the INTERMAGNET network?

Lesson plan for „How to use geomagnetic data from the INTERMAGNET network?– extended package”.

Lesson ‘How to use geomagnetic data from the INTERMAGNET network – extended’ is planned as continuation of the lesson ‘What do the compasses really indicate?’ and ‘In the pursuit of magnetic poles – extended’ which contain information and skills necessary for the proper performance of tasks.

According to the basic concept of the ERIS project, students should acquire the ability to use public databases. In the case of studies on the Earth's magnetic field, INTERMAGNET is one of the most popular global data networks. During this lesson, students will learn to calculate how many percent of one of the Earth's magnetic field changes during a magnetic storm.

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

- A computer with internet access;
- Instructions printed for each student: How to use geomagnetic data form the INTERMAGNET network? (no. 6);

Expected educational goals of the lesson:

- The goals of the lesson are the same as of the educational “Earth’s magnetic field” – extended package’.

Suggested forms of work:

- practical: exercises using the INTERMAGNET network databases

Lesson procedure:

1. Start of the lesson, organizational activities, attendance list check.
2. The teacher, during a discussion with students, reminds basic information about the earth's magnetic field. She/he can use following auxiliary questions:
  - a. How is Earth’s magnetic field created?
  - b. What is the role of Earth’s magnetic field?
  - c. Is the value of the Earth’s magnetic field constant?
  - d. How are auroras created?
3. The teacher writes on the board a task for students:

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**Familiarize yourself with the influence of a strong geomagnetic storm on the H component of the geomagnetic field in the region where you live. How much does it change?**

4. The teacher provides students with instruction 'How to use geomagnetic data from the INTERMAGNET network'. Students get acquainted with the instruction by following the instructions step by step on the chosen example. Then, they locate the geomagnetic observatory located closest to their place of residence and perform the task.
5. The teacher assists students, explains any doubts and answers possible questions.
6. After finishing work, students check the results and compare the effects of their work. The teacher assesses the students' work.