



KLiC Scenario nr. 2

TEACHERS NOTES

Unit Title:

Study of the gravitational acceleration as a function of altitude

Teaching subject:

Physics – VIII - th, IX – th grades

Students age:

14-16 years

Duration, place:

*3 hours,
The Salt Mine from Turda*

Scientific content

- *Movement of different bodies in gravitational field, Gravitational pendulum, Experimental measurement of gravitational acceleration*
- *InLOT System*

Learning objectives

The informal learning activity proposed is significant because it valorify creatively the pupils' knowledge concerning the concepts of: movement, acceleration, interaction, and also, offering to the pupils the opportunity to test their own scientific hypothesis and also to test these hypothesis' applicability in new learning contexts.

At the end of the learning activity the pupils will be able to improve and develop the competencies of:

- communication and interpersonal relationship*
- hypothesizing and elaboration of testing strategies for these hypothesis*
- development of experimental skills*
- finding information and data working – measurement of gravitational acceleration in different spots*
- using creatively AM in specific, applicativ contexts*
- exploring the real physical reality by testing AM on different moving divices*

Type of inquiry

Pupils will improve their specific practical skills and also their abilities connected with the scientific inquiry by means of **orientated discovery** and specific learning activities for this kind of learning:

- **The ability to identify questions and concepts needed in scientific inquiry.**
 - identify testable questions
 - formulate hypothesis
- **The ability to use technology in order to improve his/her own investigation and results.**
 - collect data by means of using adequate technics and instruments
 - describe an object in its relation with an other object (position, movement, direction, simetry, space dispasal or shape)
- **The ability to enounce and review the scientific explanations and models using logic and experimental evidences**
 - diferentiate the explanations trough description
 - identify trends and relations between variables from collected data
 - differentiate the observations trough deduction
 - propose an explanation based on observation
 - formulate a logical explanation about cause / effect relations between the data obtained from an experiment
- **The ability to recognize and analyze explanations and alternate models.**
 - reflects about alternate explanations

Applied technology (if any)

In this purpose, KLiC uses a colection of innovative sensors, named *InLOT system* (www.inlot.eu), that consist form the following modules:

- **SensVest** – a vest equipped with different sensors, designed with accesories for the components that measure and transmit the physiological data to the base station.
- **Leg and Arm Accelerometer** – small divices attached to leg and/or arm that realize 3-D measurements of the acceleration for leg and/or arm.
- **Ball Accelerometer** – a ball having attached an accelerometrum that measure tridimenssionaly and a communication unit that realize the transmision of data sets to the base station.
- **Base Station** – colect all transmised data.
- **User Interface Software** – a friendly interface, designed accordingly to pedgogical concepts, and that validate the data and actions processing and represent them graffically or create mathematical models coresponding to these data.

Materials (if any)

- *INLOT system*
- *PC*
- *gravitational pendulum*
- *cronometer*
- *suport*

Discussion Guide

Main question: *In which way is physics helping us to better understand the world arround us?*



Building new knowledge:

The Salt Mine from Turda represents a real salt mining history museum being one of the most important touristic sites of the city.

Teacher presents the place where the learning activity will take place, the touristic and historical importance of the salt mine both as leisure and as therapeutic purposes. Teacher presented before, in formal class settlement the system of sensors.

In the secondary school physics syllabus, in the teaching unit named „Interactions” pupils learn about gravity force and thus they use also the physical quantity named gravitational acceleration. At this age the gravitational acceleration is presented only as a physical constant without any details linked from to characteristics of this complex quantity. But, in the upper secondary school physics syllabus, the gravitational acceleration is studied more deeply in such a way that, in informal learning activities, the gravitational acceleration might be approached for both age groups.

Also, in formal setting, in classroom, there were noticed (as a function of secondary or upper secondary level) the characteristics of this physical parameter and also the factors that influence its variation. These characteristics are difficult to understand at the level of scientific information known/learned by the secondary school pupils, at this moment, respectively there are difficult to be conceptualized by upper secondary school pupils.

Teacher proposed as study theme the determination of the gravitational acceleration value by means of the experiment with a gravitational pendulum (experiment existing in the upper secondary physics syllabus) on the platform in front of the salt mine entrance and then in the deepest area of the salt mine. The depth difference between entrance and salt mine base is 112 m.

When realizing this experimental determination beside the devices existing in the physics lab kits the system KLiC is used too. Before descending in the salt mine, pupils accomplish, by means of the materials named above, the experiments at the entrance in mine, and then they attend a brainstorming sequence during which they express their own hypothesis referring to the expected value of gravitational acceleration inside the salt mine, they try to ask if the value of gravitational acceleration will increase or will decrease and also they offer possible explanations of their own hypothesis. The pupils and the teacher go down all the 112 m until the deepest point of the salt mine and the pupils realize, using the same materials and system, other experimental determinations of the gravitational acceleration. At the end of the experiments teacher and pupils discuss the hypothesis initially formulated at the entrance in the salt mine and analyze the significance of the obtained experimental results, which were their predictions/expectations, are they fulfilled, how much, causes that influenced/produced these results and conclude.

The experimentally determined values sustain the hypothesis that the gravitational acceleration decrease as the high increase, respectively, the gravitational acceleration increase as the depth increase.

Reflection/Consolidation

- observation, analyze, graphs interpretation,
- argumentation, concluding
- learning diary

Methodes, working strategies:

- brainstorming, inquiry based learning, experiment, experiential learning, learning through discovery, observation

Assessment

- ✓ sumative
- ✓ formative – exit assessment notes

Foto accelerometru

Learning trough real experiences in nonformal environment
Using the accelerometers in order to determine the gravitational acceleration at different highs

- To determine the value of gravitational acceleration on the platform at the entrance in the salt mine. Accelerometers fixed on the gravitational pendulum
- To determine the value of the gravitational acceleration inside the salt mine. The same gravitational pendulum is used in both situations
- To establish the relationship between the gravitational acceleration and high/depth.

Note: This activity values the knowledge before aquired by pupils in different learning contexts and integrated communication competences, cooperative competences, investigation competences, practical abilities, and also, social competences of interpersonal relationship, artistic and expression competences.

STUDENT WORKSHEET

Unit Title:

- *Study of the gravitational accelaration as a function of altitude*

Introduction

Curriculum related key questions

Content questions

What is the gravity force?

What is gravitation? How it works? Which is the relation between the mass and gravity? Is it realy costant the gravitational constant?

Materials (if any)

- *INLOT system - PC – gravitational pendulum, suport, observation worksheet*

Safety

Respect all the rules specific for an activity outside the classroom.

Investigation

Determine and compare the value of the gravitational accelariion on the entrance platform infront of the salt mine and the value at the depepest point in the salt mine, meaning a difference of 112 m. Find an explanation for your results.

Observation worksheet

Name and surname of the participants at the experiment:

Category: pupil; teacher; sporman;

Age: _____, **Gender:** M, F

Investigation Theme

Hypothesis Describe what you are expecting to learn from this investigation.

Experiment Design

Project Number

505519-LLP-1-2009-1-GR-KA3-KA3MP



Describe briefly the experiment. Which are the main steps in accomplishing the experiment?

Describe materials and how you use them.

Identify the variables

Determination of the value of gravitational acceleration on the entrance platform

g_1
 g_2
 g_3

Determination of the value of gravitational acceleration in the deepest point inside the salt mine

g_1
 g_2
 g_3

Which are the factors that could influence the experiment's result?

Data interpretation - Conclusions

Synthesise the quantitative data and the qualitative observations.

Name other situations where/when you may use the results of this experiment?



Further investigation

1. The relevance of the investigation: Reflect and find possible answers in order to emphasize the practical role of this activity, the benefits of science on human everyday living, the role and place of science in society, the social role of scientific researcher.

2. Conexions with real world: Reflect on the practical character of the accomplished project; importance and relevance of the data obtained by experiment, practical benefits when working with these results