Be GAliLeu GaLiLei for one day, or more...but in the other day's be yourself!

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Metadata

General Info

Title: Be Galileu Galilei for one day, or more...but in the other day's be yourself

Short description: In this exercise the students will build Galileo's telescope in groups. To do this they will have to investigate what happens to light when it changes from one medium to another (refraction) and how different types of lenses (concave and convex) perform. Through investigation, students will become familiar with the phenomenon of light refraction, the characteristics of the images produced by lenses and some of the applications of optical phenomena.

Keywords: Galileo Galilei, light, optical phenomena, refraction, concave lenses, convex lenses, focus, focal length, focal power, eyepiece, objective, different types of images produced by lenses.

Educational Context

Context: In this exercise the students will build Galileo's telescope in groups. To do this they will have to investigate what happens to light when it changes from one medium to another (refraction); what the characteristics of the different types of lenses are (converging and diverging), what the characteristics of the eyepiece and objective lenses are and what the optimum distance between them is; what the role of the reversing lens is, its characteristics and its location in relation to the eyepiece and objective lens. At the end students will

build their own telescope and present all the steps of their project, justifying their choices.

Age: 12-14 years

Prerequisites: motricidade fina (para construção dos desenhos geométrico); leitura de escalas (para utilização da régua); noções elementares de matemática.

Lv. of difficulty: medium

Aggregation Level: 8th grade of primary school

Duration: 6 lessons of 50minutes but can be extended

Educational Objectives

Areas of Competence in the Student profile developed through this activity:

- **A –** Languages and Texts
- **B –** Information and Communication
- **C –** Reasoning and Problem Solving
- **D –** Critical Thinking and Creative Thinking
- **E –** Interpersonal Relationship
- **F –** Personal Development and Autonomy
- **G –** Well-being Health and Environment
- **H –** Aesthetic and Artistic Sensitivity
- **I –** Scientific, technical and technological knowledge
- **J –** Body Awareness and Mastery

STRATEGIC TEACHING ACTIONS ORIENTED TO THE STUDENTS' PROFILE

To promote strategies that involve the acquisition of knowledge, information and other knowledge, related to the content of the Essential Learning (EA), which imply:

- need for rigour, articulation and consistent use of scientific knowledge;
- selection of relevant information in different sources (articles and books of scientific dissemination, news)
- analysis of phenomena of nature and everyday situations on the basis of laws and models
- establishing intra- and interdisciplinary relations;
- mobilisation of different sources of scientific information in problem solving, including graphs, tables, schemes, diagrams and models;
- memorisation, verification and consolidation tasks associated with understanding and using knowledge.

Promote strategies that develop students' critical and analytical thinking, focusing on:

- analyse concepts, facts and situations in a disciplinary and interdisciplinary perspective
- analyse texts with different points of view, distinguishing scientific claims from non-scientific ones
- confront arguments to find similarities, differences and internal consistency
- problematise situations about applications of science and technology and their impact on society
- debate issues requiring the support or refutation of statements about real or fictitious situations, presenting arguments and counter-arguments based on scientific knowledge.

Promote strategies that require, on the part of the student:

- argue about controversial and current scientific topics, accepting points of view different from their own
- promote strategies that induce respect for differences in characteristics, beliefs or opinions, including those of ethnic, religious or cultural origin;
- know how to work in a group, playing different roles, respecting and knowing how to listen to everyone in the group.

Promote strategies that engage, on the part of the student:

- synthesis tasks;
- planning, implementation, control and revision tasks, namely in experimental activities;
- selective recording and organisation of information (e.g. construction of summaries, records of observations, reports of laboratory activities and study visits, according to criteria and objectives).
- mobilising knowledge to question a situation;
- encouraging the search for and deepening of information;
- collecting data and opinions to analyse the themes under study;
- research tasks framed by problem-questions and supported by work scripts, with progressive autonomy.
- formulate hypotheses in relation to a natural phenomenon or a day-to-day situation;
- design situations where certain knowledge can be applied;
- propose different approaches to solving a problem situation;
- create an object, graphic, scheme, text or solution in the face of a challenge;
- analyse texts, conceptual schemes, simulations, videos with different perspectives, conceiving and sustaining an own point of view
- make predictions about the evolution of natural phenomena and the evolution of experiments in laboratory contexts
- use diverse modalities to express learning (e.g. reports, schemes, texts, mock-ups), using ICT where appropriate
- create situations that lead to decision making for individual and collective intervention leading to the sustainability of life on Earth.

Promote strategies involving tasks in which, based on criteria, the student is guided to:

- question their own knowledge, identifying the strengths and weaknesses of their learning;
- consider feedback from peers to improve or deepen their knowledge;
- based on the teacher's explicit feedback, to redirect their work, individually or in groups.

Promote strategies that create opportunities for the student:

- provide feedback to improve or deepen the group or individual work of peers;
- carry out collaborative work in different situations (interdisciplinary projects, problem solving and experimental activities).

To promote strategies and ways of organising tasks which involve, on the part of the student:

- take appropriate responsibility for what is asked of them and contractualise tasks, presenting results;
- organise and carry out tasks autonomously, including the promotion of study with the support of the teacher to achieve them, identifying obstacles and ways to overcome them
- report to others on the accomplishment of tasks and functions he/she has undertaken
- communicate the results of laboratory and research activities, orally and in writing, using scientific vocabulary appropriate to the subject, using different media;
- participate in civic actions related to the central role of Physics and Chemistry in technological development and its socio-environmental consequences.

Promote strategies that induce the student to:

- act in solidarity with others in learning tasks or in their organisation /self-help activities;
- to position oneself in situations of helping others and protecting oneself, namely by adopting protective measures adequate to laboratory activities;

Cognitive Objectives

ESSENTIAL LEARNING (AE)

Optical Phenomena

- Conclude, through experimental activities, that light can suffer refraction.

- Represent, geometrically, the refraction of light and interpret representations of these phenomena.

- Conclude, through experimental activities, about the characteristics of images in convergent and divergent lenses, analysing the procedures and communicating the conclusions.

- Explain some of the applications of optical phenomena, namely objects and instruments that include lenses.

Affective Objectives

● Realise the importance of cooperation in astronomy, science and life, in general

● Realise the importance of the evolution of technology in science

● Realise the importance of disseminating the work done, by communicating the results of laboratory and research activities, or other, orally and in writing, using scientific vocabulary appropriate to the discipline, using various media;

Psychomotor Objectives

● Be able to use mathematical formulae and to make geometric drawing and interpret scales

Subject Domain

Domain: Light

Subdomain: Optical phenomena

Orienting & Asking Questions

- ✓ Through the mentimeter we will find out if the students know Galileo Galilei. For that the students must write a word that they associate to Galileo Galilei.

- ✓ Watching the film "Galileo Galilei - Great Heroes of History" - as the film progresses some questions will appear, made with the application "edpuzzle", which the students will have to answer.
  https://edpuzzle.com/assignments/62d1d8479091af41408af53f/watch

Credits: Wikipédia - Galileu Galilei, por Justus Sustermans 1636

- ✓ To prove the truth of the heliocentric model Galileo used a telescope (refracting telescope). To do this he had to understand how the "glass spy" (the name given to the first telescope whose patent was granted to Hans Lipperhey, a spectacle maker, in 1608 in Holland) worked and then perfect it to use for astronomical purposes.

Créditos: http://www.fisica-interessante.com/biografia-galileu-galilei.html

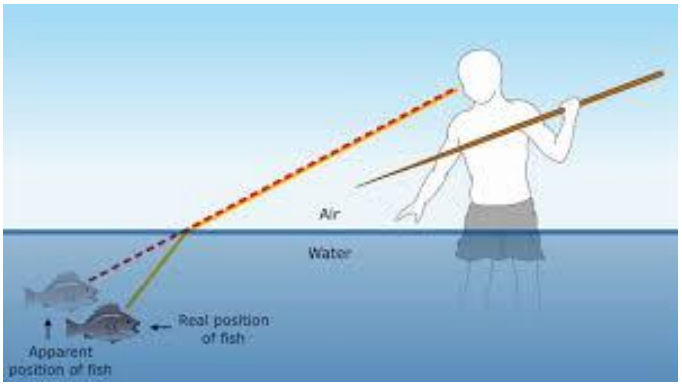
WHAT DID GALILEO OBSERVE WITH HIS TELESCOPE?

Check the link below and "through a simulator, made by the Galileo Museum, it is possible to observe what Galileo saw through his telescope".

https://sites.google.com/site/ndcm2014grupo01mat/simulador-do-telescopio

WHAT PHYSICAL PHENOMENON IS BEHIND GALILEO'S TELESCOPE?

Why is it that when we put a pencil in a glass of water it looks like it's broken? ... Why do we never have the correct perception of the depth of objects that are in the water?



Credits: https://azeheb.com.br/blog/entenda-a-refracao-da-luz/

The refraction of light consists of the deviation of the direction of propagation of light when passing from one transparent or translucent medium to another (unless it is incident perpendicular to the surface separating the media). This change in direction is due to the change in the speed of light propagation when passing from one medium to another. The more refrangent (denser) the medium, the lower the speed of light propagation, and therefore the closer the refracted ray will be to the normal to the surface separating the media, i.e. the smaller the angle of refraction.

The greater the difference between the velocities of propagation in the two media, the greater the deviation of the light.

When the incident ray passes through a lens (convergent or divergent) through the optical centre (O) it is not deflected.

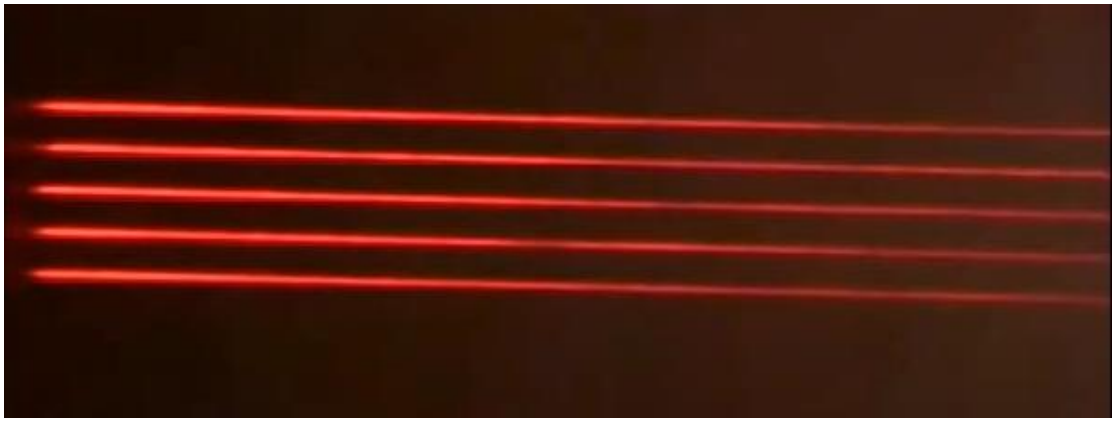
THE INTENSITY OF THE REFRACTED RAY IS EQUAL TO THAT OF THE INCIDENT RAY?

Credits: https://www.santillana.pt/files/DNLCNT/Priv/_11809_c.book

The light , when propagating in a transparent medium and incident on the separation surface with another transparent medium , suffers simultaneously reflection, absorption and refraction. The intensity of the refracted ray is less than that of the ray incident obliquely on the surface separating the media, because "part of this incident ray" is absorbed and/or reflected.

WILL ALL LENSES BE THE SAME?

- ✓ Video viewing: https://youtu.be/QONtGu9qIaQ



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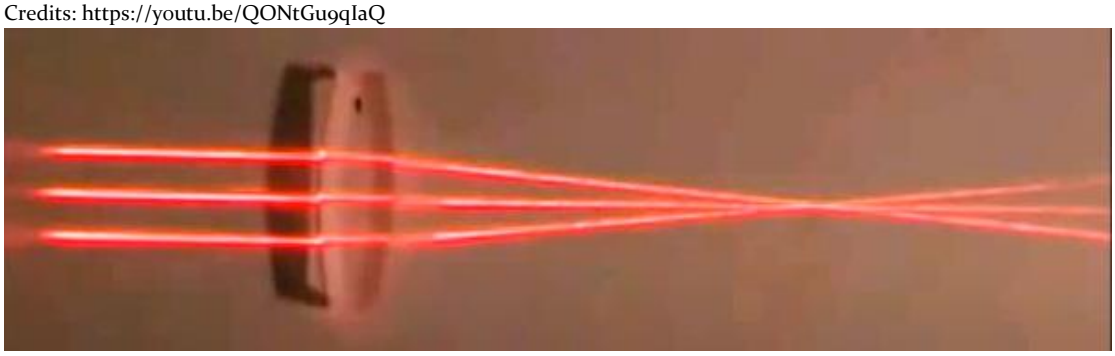

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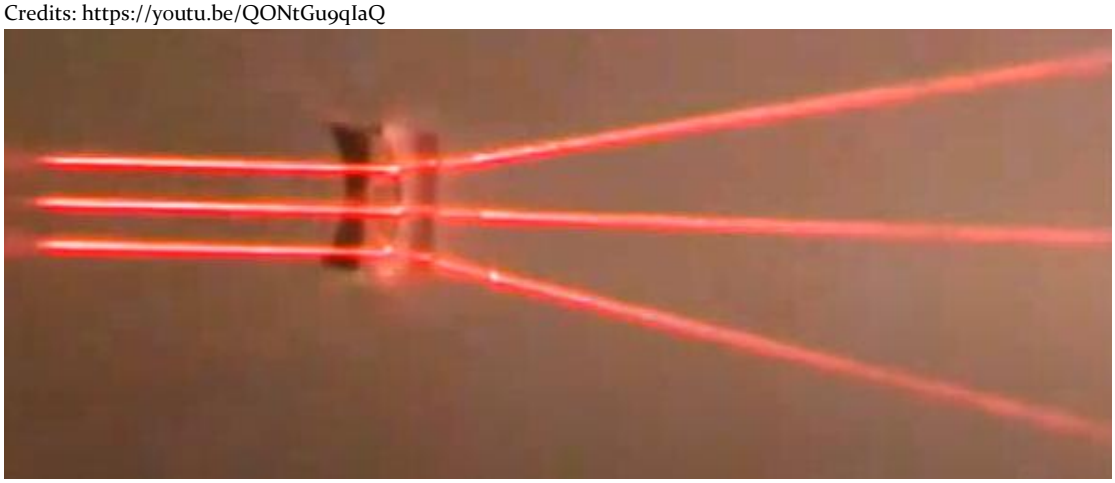
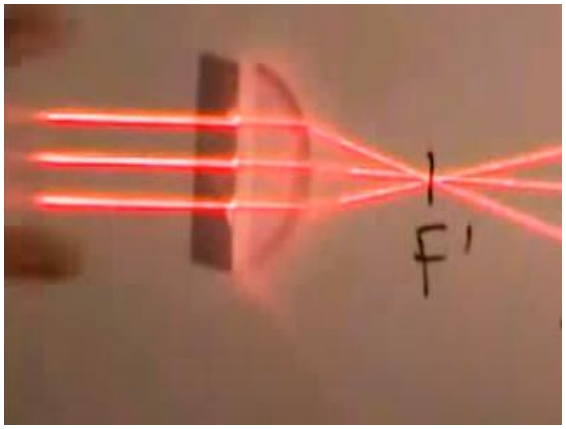


Credits: https://youtu.be/QONtGu9qIaQ

In a lens light undergoes two refractions, one when it passes from air to glass (or plastic) and another when it passes from glass to air.

The refracted rays converge at a single point, the focus (F).



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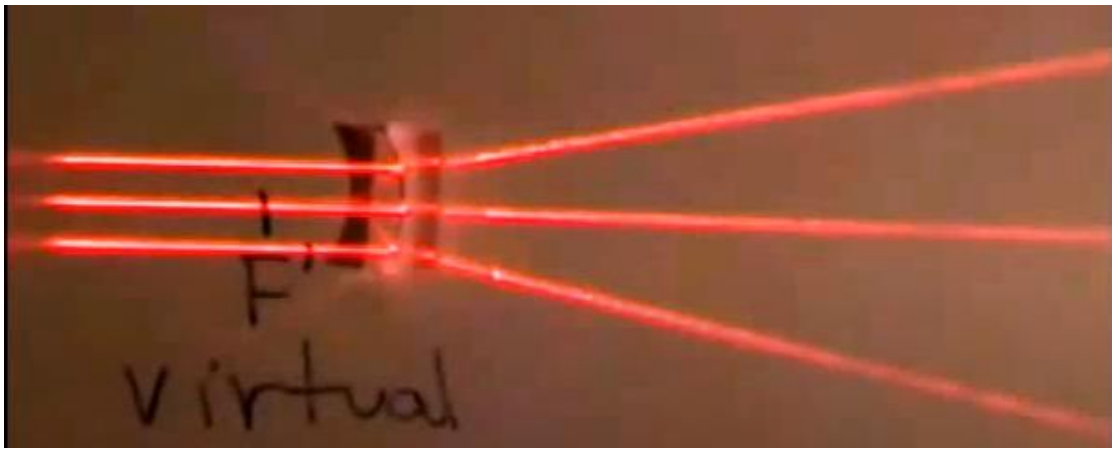

Credits: https://youtu.be/QONtGu9qIaQ

The distance between the focus and the centre of the lens is called the **focal length (f)**. The shorter the focal length of a lens, the more convergent/divergent the lens is.

The **focal power (P)** or **vergence (V)** of a lens indicates its ability to make the light incident on the lens converge or diverge. Its I.S. unit is the **diopter (D).**

A converging lens has a positive focal length.

A diverging lens has a negative focal length.

$$P = 1/f$$

WHAT ARE THE CHARACTERISTICS OF THE IMAGES FORMED BY THE LENSES?

On the one hand we have the **real images** (they are formed on the side of the lens opposite to the one where the object is):

- in converging lenses

- they are inverted

- they are formed in front of the lens

- they can be projected onto a screen

- they can be bigger, smaller or of the same size as the object.

On the other hand we have **virtual images** (they are formed on the same side of the lens as the object):

- in convergent and divergent lenses

- are straight

- are formed behind the lens

- they cannot be projected onto a screen

- they are bigger than the object in a convergent lens

- are smaller than the object in a diverging lens

WHAT ARE CONVERGING LENSES AND WHAT ARE THEIR CHARACTERISTICS?

Convergent lenses are convex and have thin edges (the thickness in the central part of the lens is greater than at the edges).

- In converging lenses the focus is real because it can be projected onto a target (it is formed in front of the lens). They have a positive focal power.

- ***The image of a real object formed with a converging lens can be (depending on the distance of the object to the lens) of three types:***

- **Virtual image, right and larger than the object...** if the distance from the object to the lens is less than the distance from the focus to the lens.

- **Real image, inverted and smaller than the object...** if the distance from the object to the lens is greater than twice the distance from the focus to the lens.

- **Real image, inverted and larger than the object...** if the distance from the object to the lens is greater than the distance from the focus to the lens and less than twice the distance from the focus to the lens.

- **Some applications of converging lenses:** spectacles, contact lenses, binoculars, projectors, telescopes, optical microscopes, cameras, magnifiers.

WHAT ARE DIVERGENT LENSES AND WHAT ARE THEIR CHARACTERISTICS?

Divergent lenses are concave and have thick edges (the thickness in the central part of the lens is less than on the edges).

In divergent lenses the focus is virtual, so it cannot be projected onto a target (it forms behind the lens). They have a negative focal power.

WHAT LENS DID GALILEO GALILEI USE ON HIS BEZEL?

Galileo's telescope (refracting telescope) was basically a tube with two lenses: one convex (objective - very weak lens - lens used in reading glasses) and one concave (ocular - very strong lens, magnifying glasses used by watchmakers and geologists) placed at the right distance. The greater the difference between the focal lengths of the two lenses, the greater the telescope's magnification will be. The image will be larger, but upside down. To make the image straight, a reversing lens (strong lens) is used.

In this activity students will explore the phenomenon of refraction, the characteristics of different types of lenses such as focus, focal length, focal power as well as different images produced...

... But will all this knowledge be needed by students to build Galileo's telescope? What are the questions whose answers will the students need to carry out this project

- ✓ The pupils will formulate questions whose answers are of interest to them for the implementation of the project

- ✓ They then formulate hypotheses for their answers. When formulating their hypotheses, they should think of a question and then think of a way to test it. A hypothesis should contain a statement and then an explanation.

Exº The greater the focal power of the lens, the shorter the focal length. This is due to the fact that the higher the focal power of the lens, the greater the power to make the light ray converge/divergence. This hypothesis can be tested using an optics bench simulador

- ✓ Students will use an optical bench and optical bench simulators to understand how different lenses work.

https://www.golabz.eu/lab/optical-bench

http://relle.ufsc.br/labs/12

https://www.golabz.eu/lab/lens

https://phet.colorado.edu/pt_BR/simulations/bending-light

https://phet.colorado.edu/sims/html/geometric-optics/latest/geometric-optics_pt_BR.html

- ✓ Students will use a telescope simulator to understand the behaviour of the different lenses and the positioning each one should have.

https://astro.unl.edu/classaction/animations/telescopes/telescope10.html

- ✓ Students build Galileo's telescope
  For help they can watch the video:

https://www.youtube.com/watch?v=7h4z7JTLX8k

- ✓ The work of each group will be presented to the class

An important part of the scientific process is communicating the results of the work done.

The students will have to prepare a presentation as a group, in which they present in a summarized way the various parts of the project, from the beginning to the end of the construction of Galileo's telescope, with all the hypotheses, conclusions and difficulties. They should comment on how the whole process of the construction of Galileo's telescope went, and if they started this project now, what would they do differently.

- ✓ They use the stellarium to find out at what time they can see Jupiter and near which constellations they can observe it. Using the stellarium the students will understand where they should point their telescopes. https://stellarium.org/pt/

- ✓ The students will make a night observation with the telescopes they have built and not only...