LEARNING UNIT

Galileo Galilei:
the mathematician, the scientist and the the communicator.

CLIL Course – A.S. 2024/2025

Proff. Conte, Fasano, Laghezza, Micoli

Lesson 1

From Aristotle to Galileo, the unification of terrestrial and celestial PHYSICS

(Prof. Micoli)

Lesson 2

Galileo's observations in ART and in LITERATURE

(Prof.ssa Laghezza)

Lesson 3

From Galileo's observations of the Moon to the equation of the parabola in MATHS

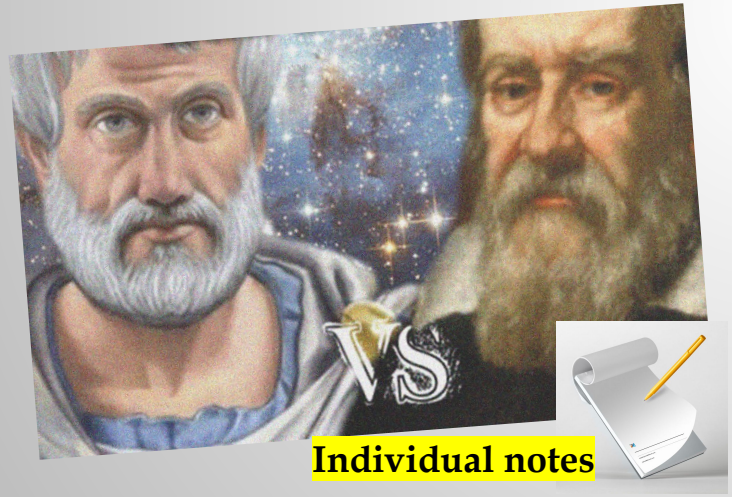
(Proff. Conte e Fasano)

Lesson 1

From Aristotle to Galileo, the unification of terrestrial and celestial PHYSICS

PRE-TEACHING VOCABULARY

The teacher introduces the topic and launches a BRAINSTORMING to activate prior knowledge.



Individual notes

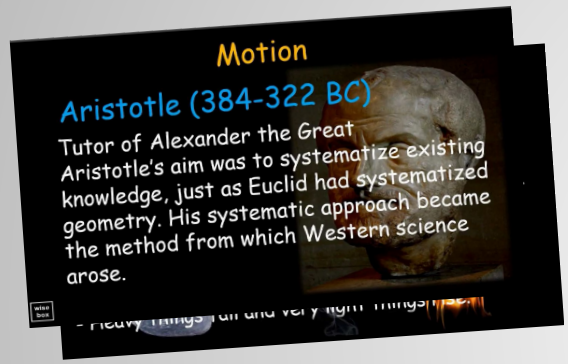
INPUT

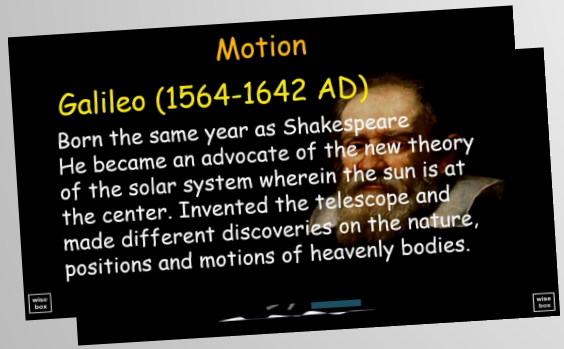
The teacher uses a VIDEO to explain Aristotle and Galileo's conception of motion.

https://drive.google.com/file/d/1UbYYhjSUBDW981KqRm2a6u1WyVwS4PlM/view?usp=drive_link

INPUT

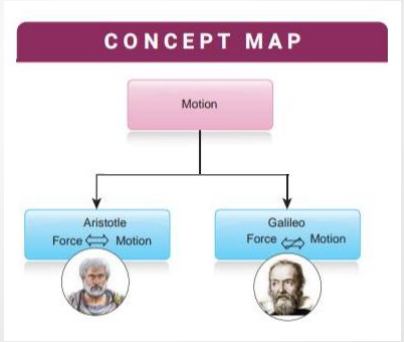
Starting from the video, teacher prepares slides and assigns them to the students.





PRODUCTION

Create a CONCEPT MAP on the two different conceptions of motion starting from the slides.



INTERACTION

The students share ideas and discuss the differences between Aristotle's and Galileo's approaches.

Is the idea of the perfection of the heavens correct?

The teacher assigns a TEXT describing Moon's observations using the telescope.

The telescopic evidence

In Galileo's time, everyone was convinced that the heavens were eternal and could not change (Geocentric and Heliocentric model).

The sudden appearance of a new star in 1604 (SN 1604 - Supernova) convinced Galileo, like Tycho and Kepler, that a change in the starry sky conflicted with the old idea that the stars could not change.

This new star fueled Galileo's interest in astronomy that lasted throughout his life. A Dutchman *"had built a telescope by means of which visible objects, though very distant from the eye of the observer, were distinctly seen as if they were near."*

Galileo set to work to build such an instrument himself. In his book "Sidereus Nuncius" (The Star Message) he writes:

> *"Finally, sparing neither labor nor expense, I succeeded in constructing for myself an instrument so excellent that objects seen by means of it appeared nearly one thousand times larger and over thirty times closer than when regarded with our natural vision. [...]"*
>
> *"It would be superfluous to enumerate the number and importance of the advantages of such an instrument at sea as well as on land. But forsaking terrestrial observations, I turned to celestial ones, and first I saw the moon from as near at hand as if it were scarcely two terrestrial radii away. [...]"*

What he saw led him to the conviction that:

> *"... the surface of the moon is not smooth, uniform, and precisely spherical as a great number of philosophers believe it (and other heavenly bodies) to be, but is uneven, rough, and full of cavities and prominences, being not unlike the face of the earth, relieved by chains of mountains, and deep valleys."*

Galileo did not stop at that simple observation, so contrary to Aristotle's idea of celestial perfection. He supported his conclusions with different types of evidence, including measurements. He developed a method for determining the height of a mountain on the moon from the shadow that could be seen projected on it.

The students read the text and underline key concepts, focusing on the description of the Moon's surface.

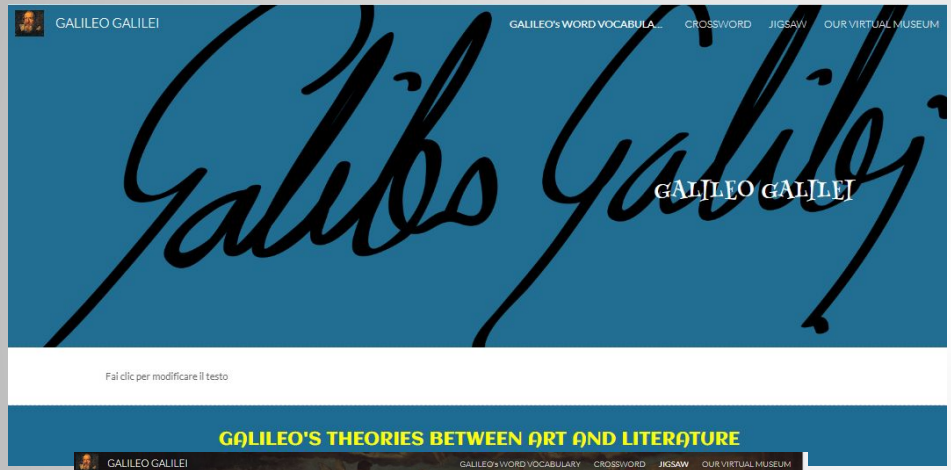
The students THINK about the answer.

The students discuss in PAIRS how the discovery of mountains and craters on the Moon contradicts the Aristotelian idea of celestial perfection.

The whole class SHARE how these observations challenged the idea of the perfection of the heavens.

Lesson 2

Galileo's THEORIES in ART and in LITERATURE



ENJOY WITH
GALILEO'S GOOGLE SITE
CLICK ON THIS LINK IF YOU WANT TO EXPLORE GALILEO'S WORLD IN ART AND LITERATURE

https://sites.google.com/majorana.net/galileogalilei/galileos-word-vocabulary

Lesson 3

From Galileo's observations of the Moon to the equation of the parabola in MATHS

How do we introduce the topic?
Ice breaking activity:
What do you see?

4Cs
Content & Communication

Brain storming through
WORD CLOUD
www.menti.com

The students describe what they see in the pictures…this allows to introduce the ***pre-teaching vocabulary***:

- Parabola
- Symmetry
- Trajectory
- Vertex
- Focus
- Directrix
- Concavity
- Arch

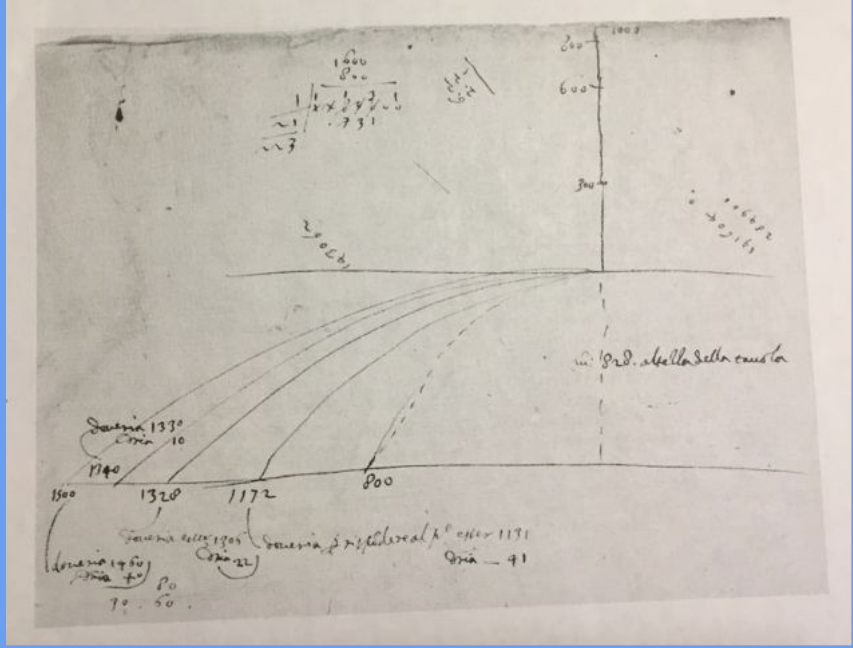
Sparkling attention

BICS

What does Galileo have to do with parabolas?

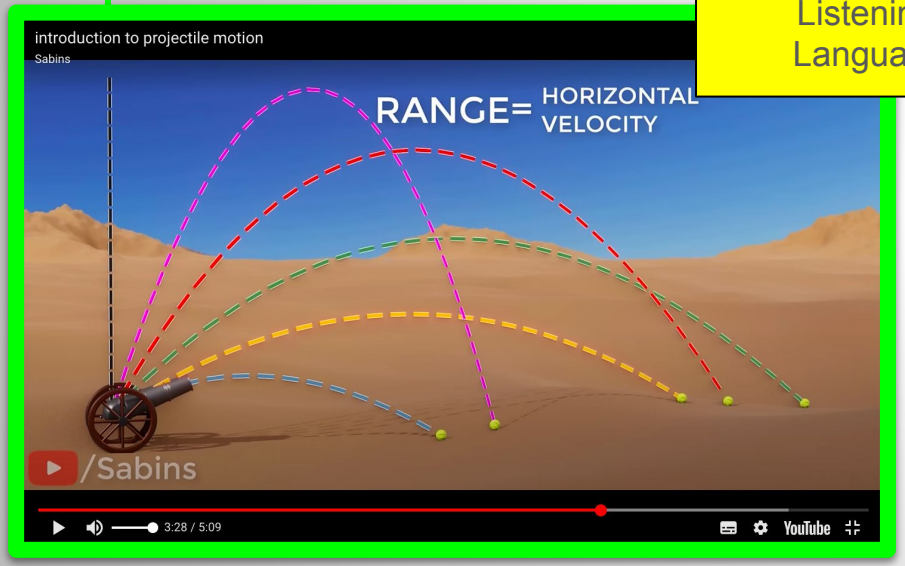
Galileo and the motion of the projectile:

the parabolic motion



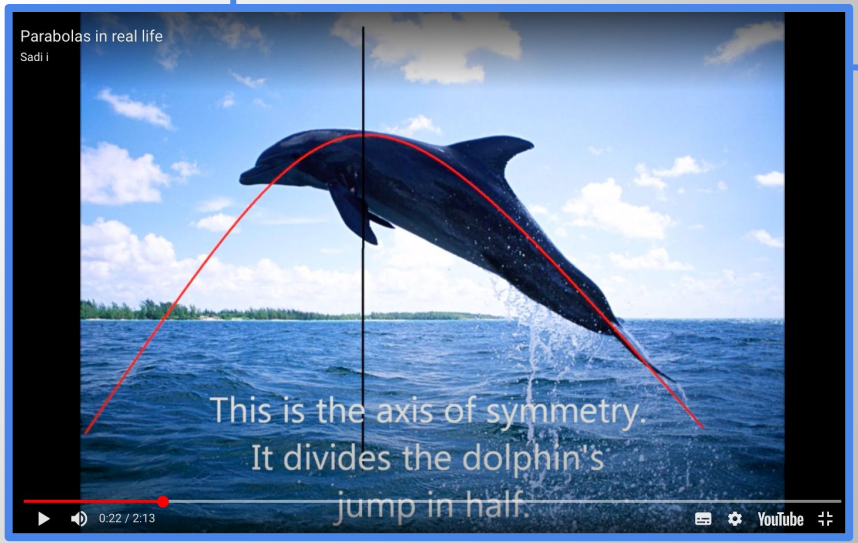
Florence National Library - Galileo, 1608

Let's understand the fundamental of the ***projectile motion*** through the following video:



Listening and comprehension
Listening and speaking
Language development

Group discussion:
Ask students if they can think of other examples of parabolas in real life: satellite dishes, bridges, trajectories of basketball ball shot…



4Cs
Communication & Culture

1. Exploration of the parabola

The teacher introduces the ***standard equation*** of a parabola and uses ***MatLab*** as graphing tool

Collaborative learning
Interactive activity
Language development

2. Group activity: Graphing parabolas

Scaffolding

PARABOLA

The parabola is the geometric locus of points in the plane equidistant from a fixed point ca
the **FOCUS** and from a fixed straight line called the **DIRECTRIX**.

$y = ax^2 + bx + c$

GENERIC EQUATION	$y = ax^2 + bx + c$	$y = 4x^2 - 3x - 1$
VERTEX	$V(-\frac{b}{2a}, -\frac{\Delta}{4a})$	$x_V = -\frac{-3}{2\cdot(4)} = +\frac{3}{8}$ $y_V = -\frac{(-3)^2 - 4\cdot4\cdot(-1)}{4\cdot4} = -\frac{9+16}{16} = -\frac{25}{16}$ We get: $\Delta = b^2 - 4ac = 25$
FOCUS	$F(-\frac{b}{2a}, \frac{1-\Delta}{4a})$	$x_F = -\frac{-3}{2\cdot(4)} = +\frac{3}{8}$ $y_F = \frac{1-25}{4\cdot4} = \frac{-24}{16} = -\frac{3}{2}$
AXIS of SIMMETRY	$x = -\frac{b}{2a}$	$x = +\frac{3}{8}$
DIRECTRIX	$y = -\frac{1+\Delta}{4a}$	$y = -\frac{1+25}{4\cdot4} = -\frac{26}{16} = -\frac{13}{8}$

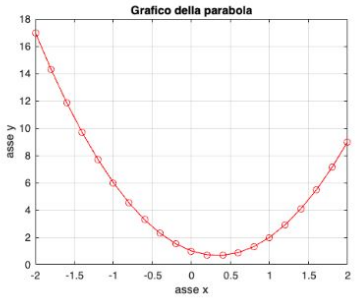
Class discussion: WASH BACK

Bring the class back together and ask each group to present their graphs and their findings

Graphing parabolas in MatLab

dow:

```
];    % Domain
x+1;  % Parabola equation
>> figure              % Open graphic window
>> plot(x, y,'ro-');
>> title('Grafico della parabola')
>> xlabel('asse x')
>> ylabel('asse y')
>> grid on
```



LET'S DETERMINE THE CHARACTERISTICS OF THE PARABOLA

GENERIC EQUATION	$y = ax^2 + bx + c$	$y = 3x^2 - 2x + 1$
	$V(-\frac{b}{2a}, -\frac{\Delta}{4a})$	
	$F(-\frac{b}{2a}, \frac{1-\Delta}{4a})$	
SIMMETRY	$x = -\frac{b}{2a}$	
RIX	$y = -\frac{1+\Delta}{4a}$	

LET'S DRAW THE PARABOLA

$y = ax^2 + bx + c$		$y = 3x^2 - 2x + 1$
1. CONCAVITY	The concavity depends on the sign of a: - **a>0** concavity upwards (**it smiles**) - **a<0** concavity downwards (**it cries**)	
2. VERTEX	$V(-\frac{b}{2a}, -\frac{\Delta}{4a})$	
3. INTERSECTION WITH ***X-AXIS***	We have to solve the system: $\begin{cases} y = ax^2 + bx + c \\ y = 0 \quad (x-axis\ equation) \end{cases}$ We get: $ax^2 + bx + c = 0$	

4Cs
Content & Cognition

Group activity - PRODUCTION

Divide Students in groups of 4 and assign to each group the following task: research an application of the parabola in Science or in Technology or in Engineering.
Students will find a practical problem related to the application that will lead to set up the equation of the parabola. They will determine key points like the vertex and the intersections with the x-axis and will represent the graph.
Each group will present the research to the class.

Cooperative learning

Interactive activity

4Cs
Content & Cognition
Communication

Language development

CALPS

Bloom Tassonomy
applying and analyzing

Problem solving

EXAMPLE - Problem:
An asteroid is on a collision course with Earth. Scientists have tracked its position and determined that it is currently located at coordinates (100, 200) in a two-dimensional space. The asteroid is moving with a velocity that can be approximated by the equation of a parabola…

ASSESSMENT

1. **Teacher feedback**
   during class discussion and during presentation of group works
2. **Group activity presentation**
   teacher evaluates the group production
3. **Individual test**
   multiple choice test

TEST

Exercise 1:
Identify which of the following equ
1. $y = 3x^2 + 2x + 1$
2. $y = 5x + 7$
3. $y = \frac{1}{2}x^3 - 4x + 2$
4. $y = -2x^2 + 4$
5. $y = 7$

Instructions for Students:
Identify which equations represent
parabolic and explain why they fit

Exercise 2:
Equation: $y = 2x^2 - 4$

- Instructions:
1. Identify the vertex and the direction of opening.
2. Draw the graph of the parabola.
3. Discuss how the coefficient of x^2 (which is 2) affects the width and directio
parabola.

St. Louis - California

Conclusions and reflection

1. ***Recap:*** "To summarize, we learned that parabolas are not just mathematical concepts; they have real-world applications in various fields."
2. ***Reflection:*** "How do you think understanding parabolas can help us in our daily lives or future careers?"