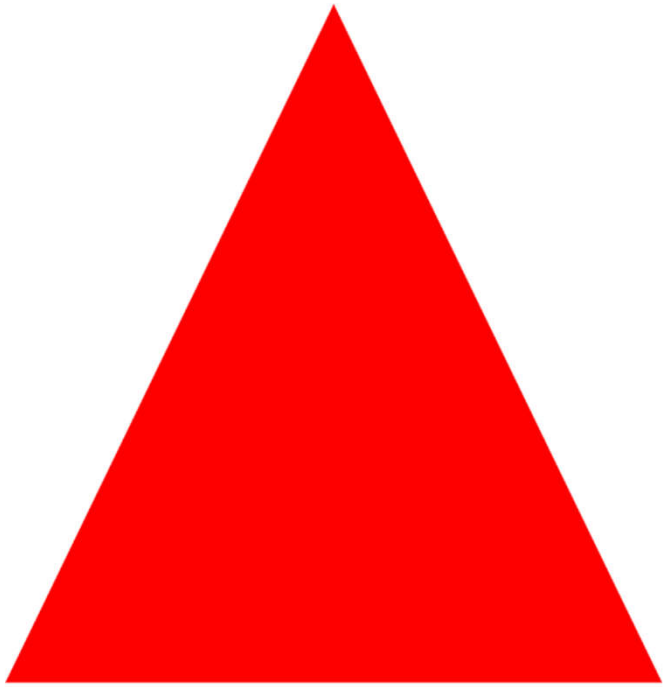
Insegnare STEAM con la realtà aumentata

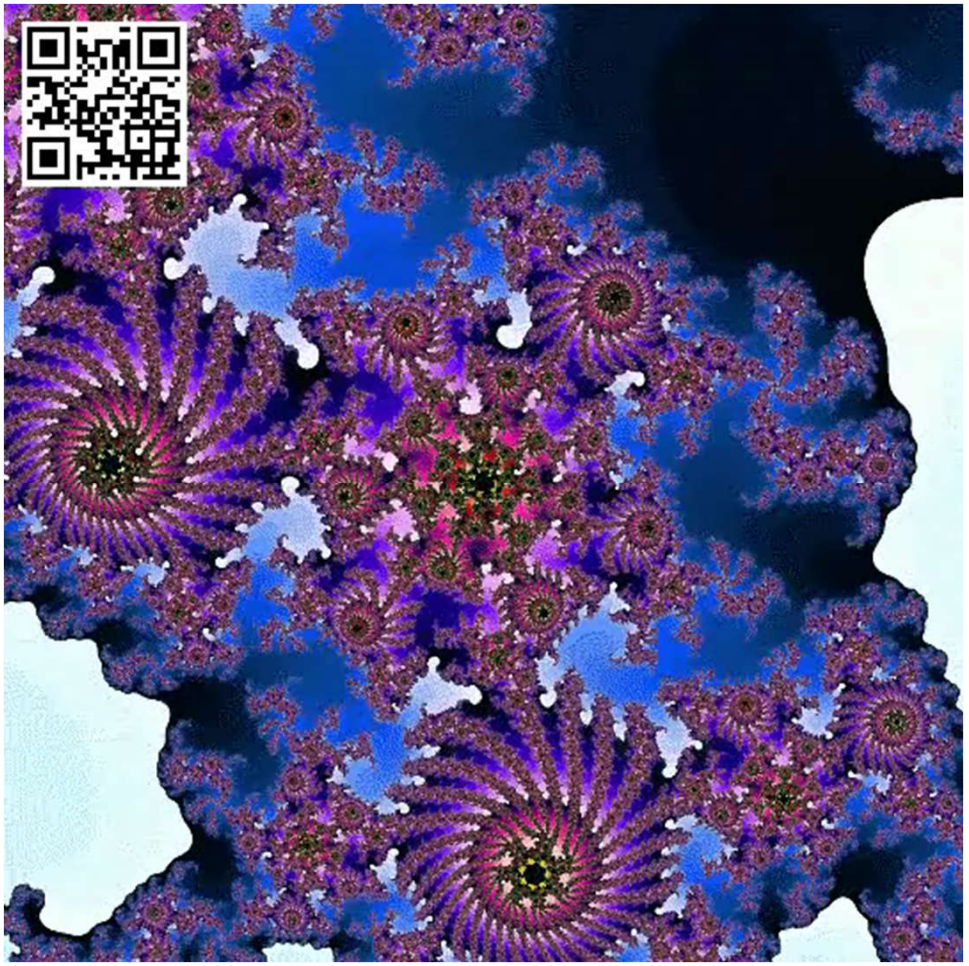
Grzegorz Karwasz

Lezione 5: Matematica – regina delle scienze
Parte III: Didattica digitale ed aumentata

«Inutile perdere il tempo per operazioni che con la mia invenzione qualsiasi contadino potrà fare» (W. Leibniz)

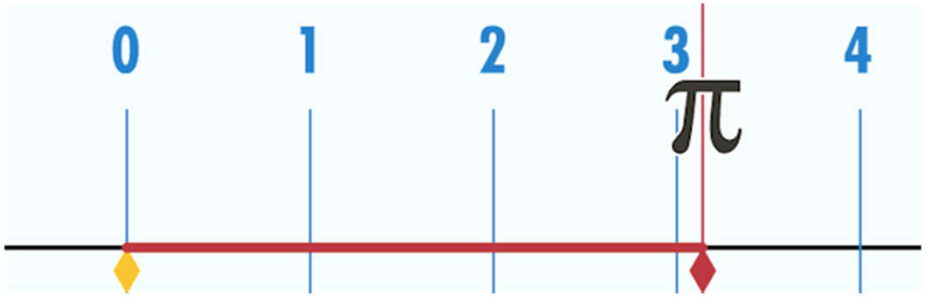
Ancora i frattali

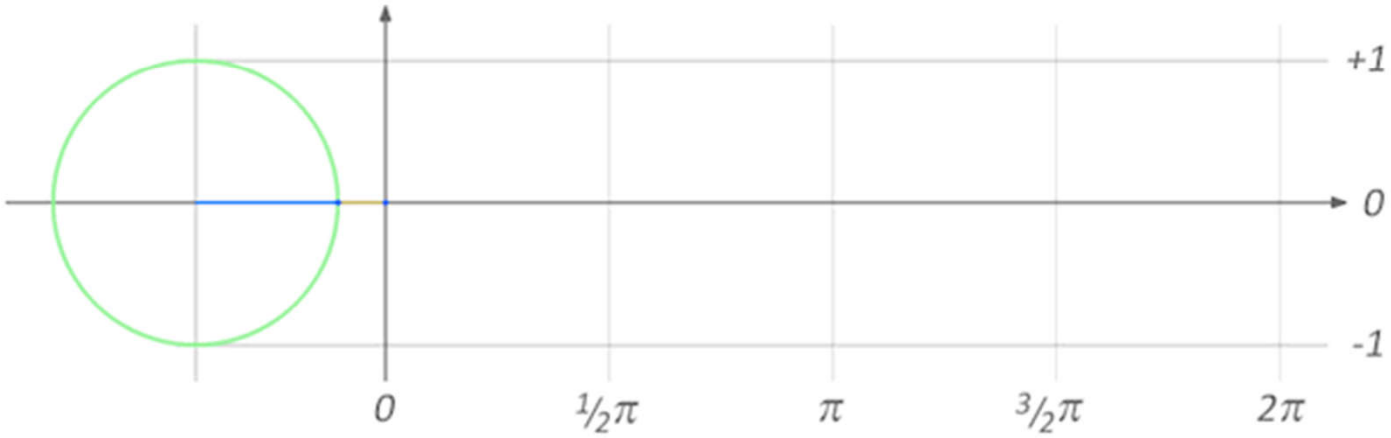




Il triangolo di Sierpinski
https://giphy.com/gifs/animation-trippy-psychedelic-xUPGcxdhS5isNwqsuY

Ancora il numero pi-greco





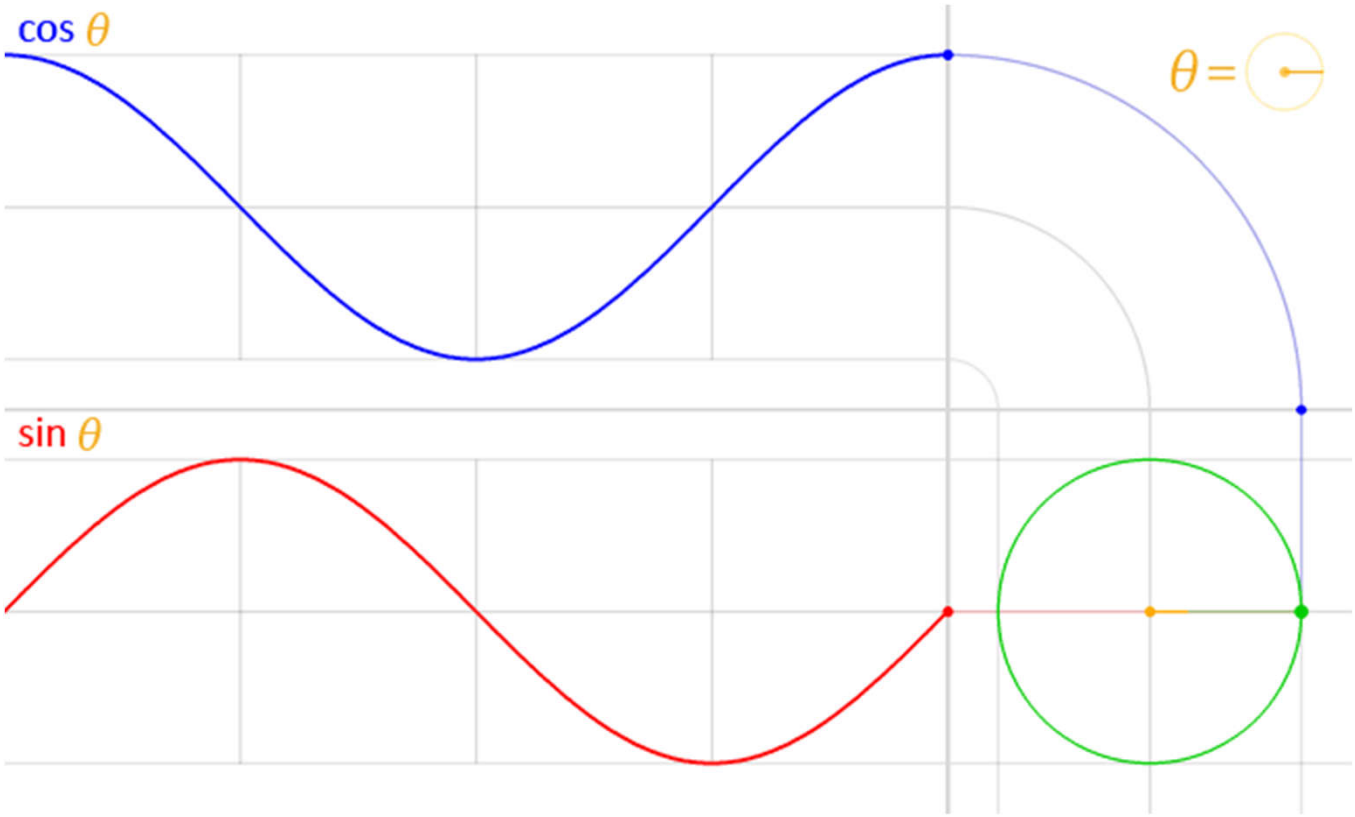
https://archive.nerdist.com/three-gifs-that-make-pi-instantly-understandable/

Due esempi del moto

Il cerchio è la somma di seno e coseno

$x = \cos \theta$

$y = \sin \theta$



https://commons.wikimedia.org/wiki/File:Circle_cos_sin.gif

La cicloide (per matematici)
oppure brachisto-crona (per fisici)

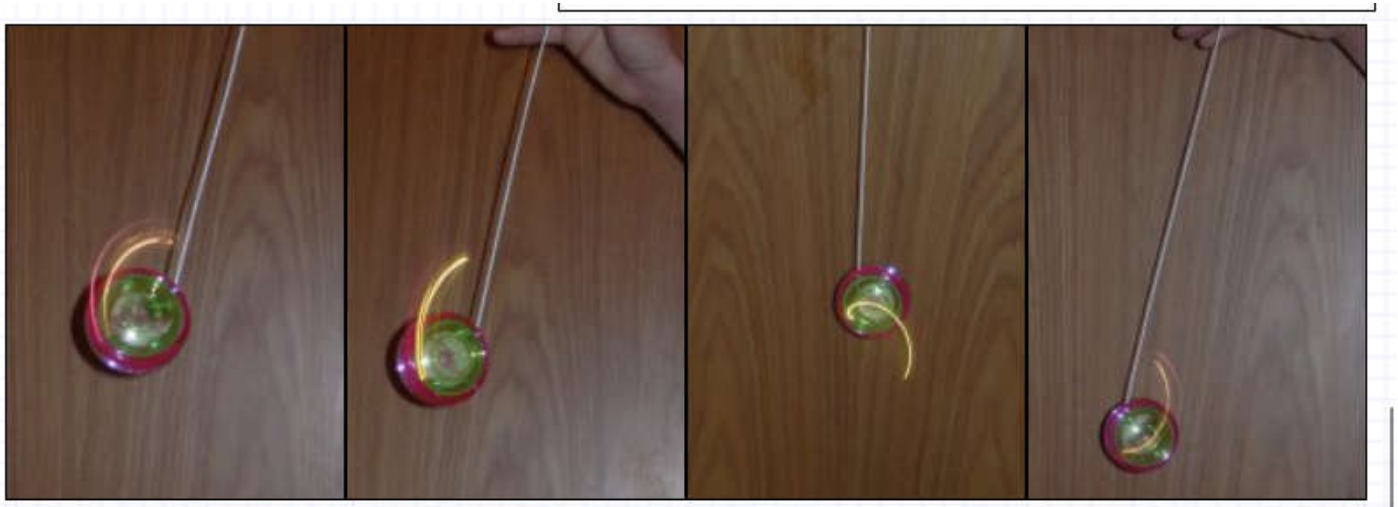
$$x = r(t - \sin t)$$
$$y = r(1 - \cos t),$$

https://en.wikipedia.org/wiki/Cycloid

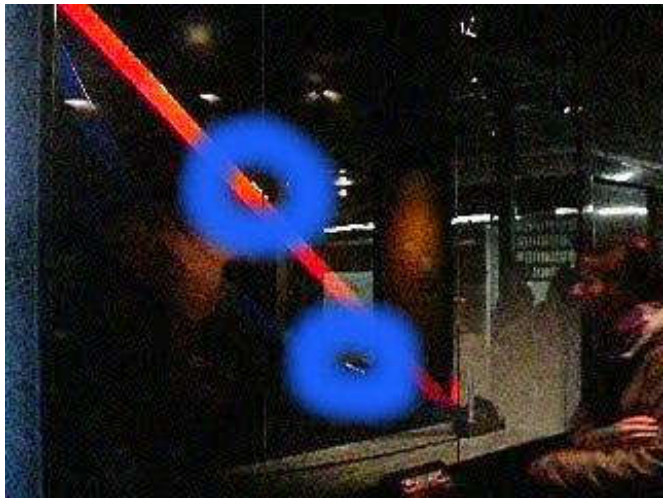
Brachistrocrona (J. Bernoulli)

http://dydaktyka.fizyka.umk.pl/zabawki1/index-it.html

Brachistrocrona (J. Bernoulli)



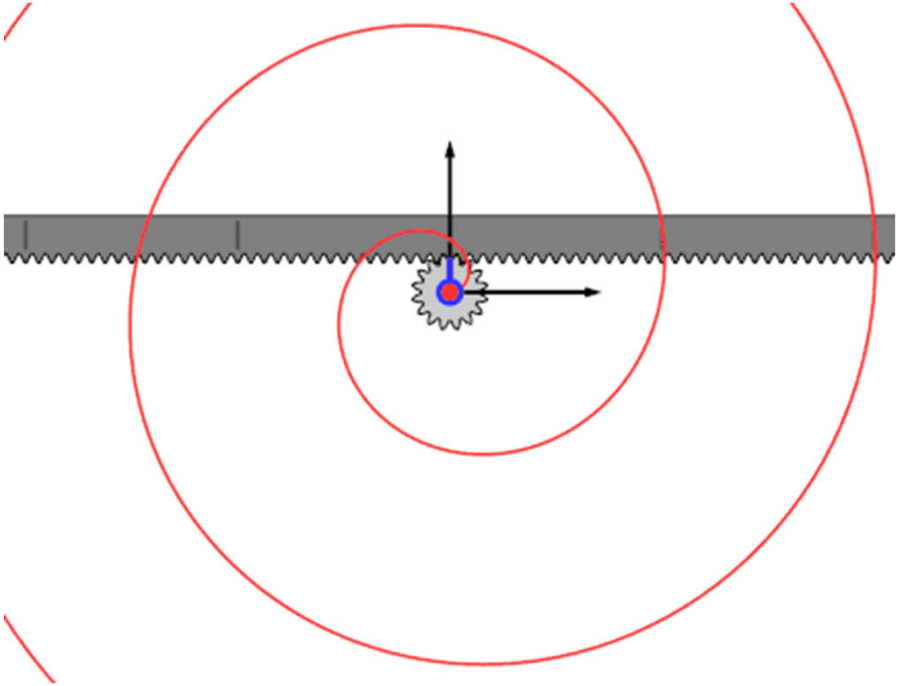
Il problema della caduta più rapida fu posto da un matematico svizzero, Johann Bernoulli, nel 1696 e risolto poco dopo dal fratello, Jakob Bernoulli, che era matematico e fisico: in base alla legge di Bernoulli gli aerei volano e la pallina resta sospesa nella corrente del phon..

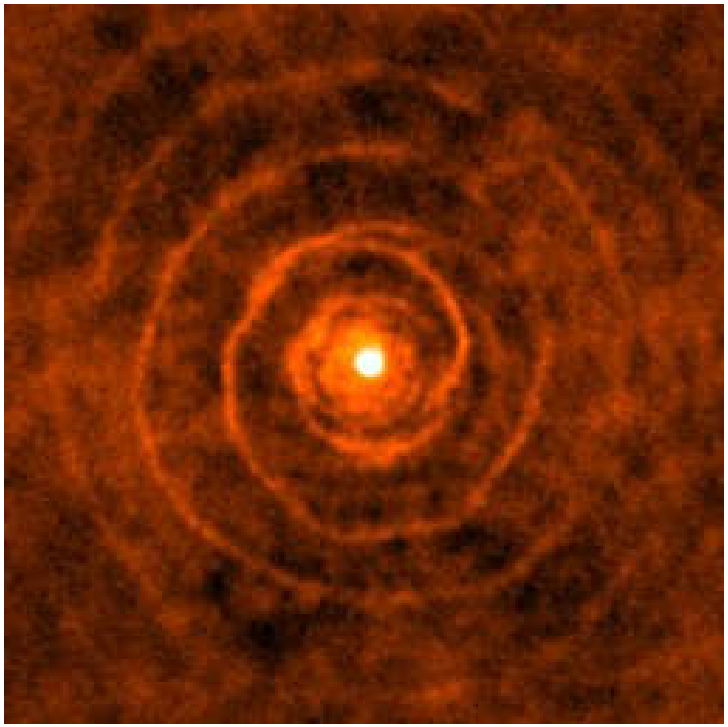


http://dydaktyka.fizyka.umk.pl/zabawki1/files/mech/faster-it.html

Spirale di Archimede

$r = a + b \cdot \theta$





https://upload.wikimedia.org/wikipedia/commons/0/00/Archimedean_Spiral_animation_with_Gears_positive_tracing.gif

https://en.wikipedia.org/wiki/Archimedean_spiralAtacama Large Millimeter Array image of LL Pegasi

Una spirale più bella

https://www.geeksforgeeks.org/draw-colorful-spiral-web-using-turtle-graphics-in-python/

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Draw Colorful Spiral Web Using Turtle Graphics in Python

Difficulty Level : Basic • Last Updated : 20 Oct, 2020

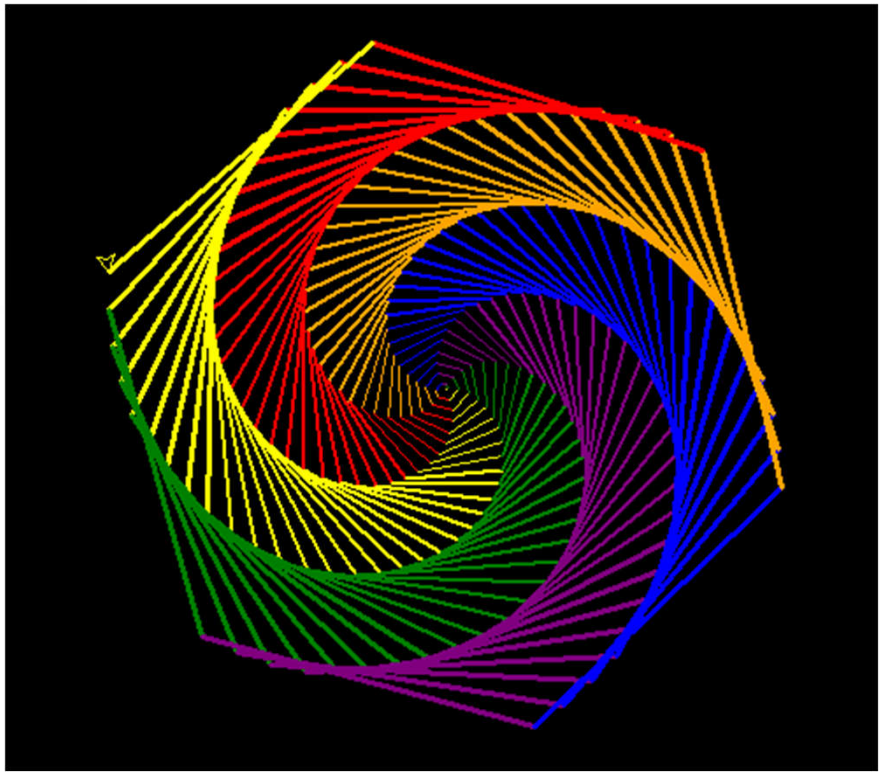
Read Discuss

Prerequisite: Turtle Basics

"Turtle" is a Python feature like a drawing board, which lets us command a turtle to draw all over it. This comes packed with the standard Python package and need not be installed externally.

Methods used:

- **forward(value):** moves the turtle in the forward direction.
- **turtle.Pen():** setup the turtle pen
- **speed(value):** changes the speed of the turtle
- **width(value):** set the width
- **left(value):** moves the turtle left.



Math is Fun: pentagono regolare

A *regular pentagon* has five lines of reflectional symmetry, and rotational symmetry of order 5 (through 72°, 144°, 216° and 288°). The diagonals of a convex regular pentagon are in the golden ratio to its sides. Given its side length t, its height H (distance from one side to the opposite vertex), width W (distance between two farthest separated points, which equals the diagonal length D) and circumradius R are given by:

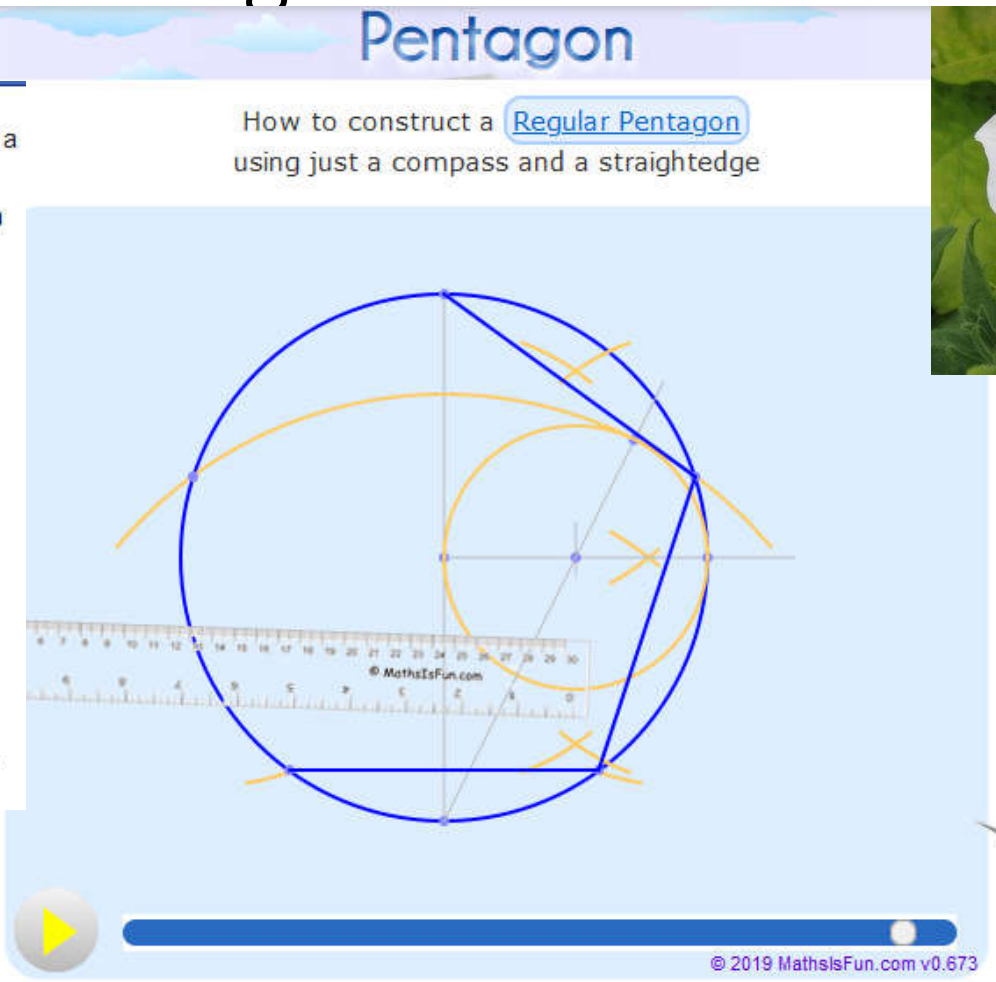
$$H = \frac{\sqrt{5+2\sqrt{5}}}{2}\,t \approx 1.539\,t,$$

$$W = D = \frac{1+\sqrt{5}}{2}\,t \approx 1.618\,t,$$

$$W = \sqrt{2-\frac{2}{\sqrt{5}}}\cdot H \approx 1.051\,H,$$

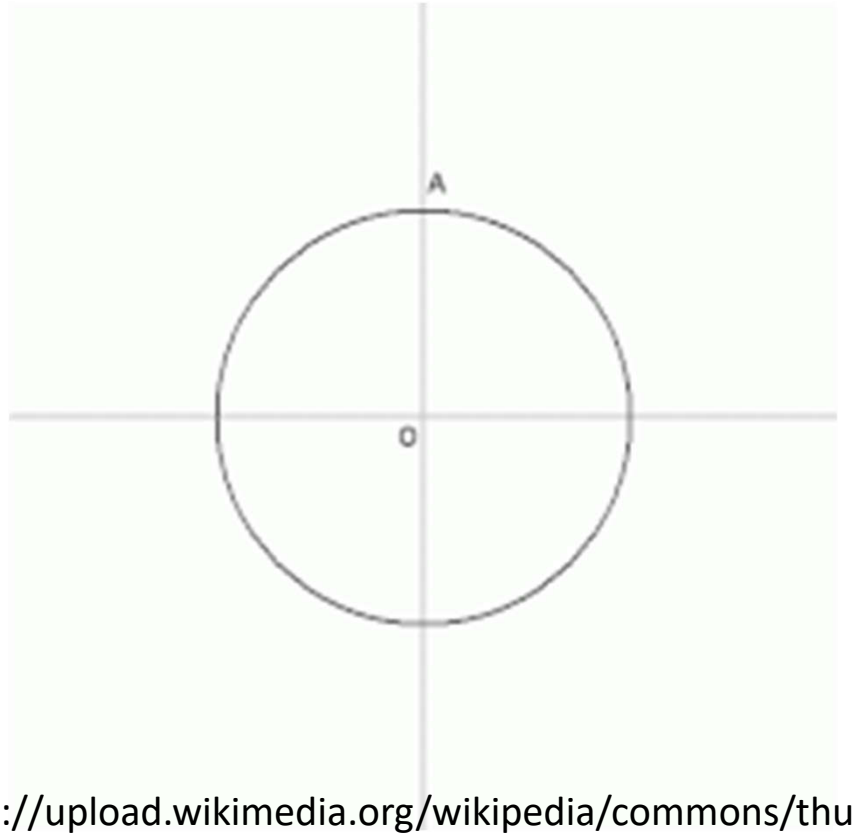
$$R = \sqrt{\frac{5+\sqrt{5}}{10}}\,t \approx 0.8507\,t,$$

$$D = R\sqrt{\frac{5+\sqrt{5}}{2}} = 2R\cos 18^\circ = 2R\cos\frac{\pi}{10} \approx 1.902\,R.$$



https://en.wikipedia.org/wiki/Pentagon
https://www.mathsisfun.com/geometry/construct-pentagon.html

Pentagono regolare: due altre costruzioni



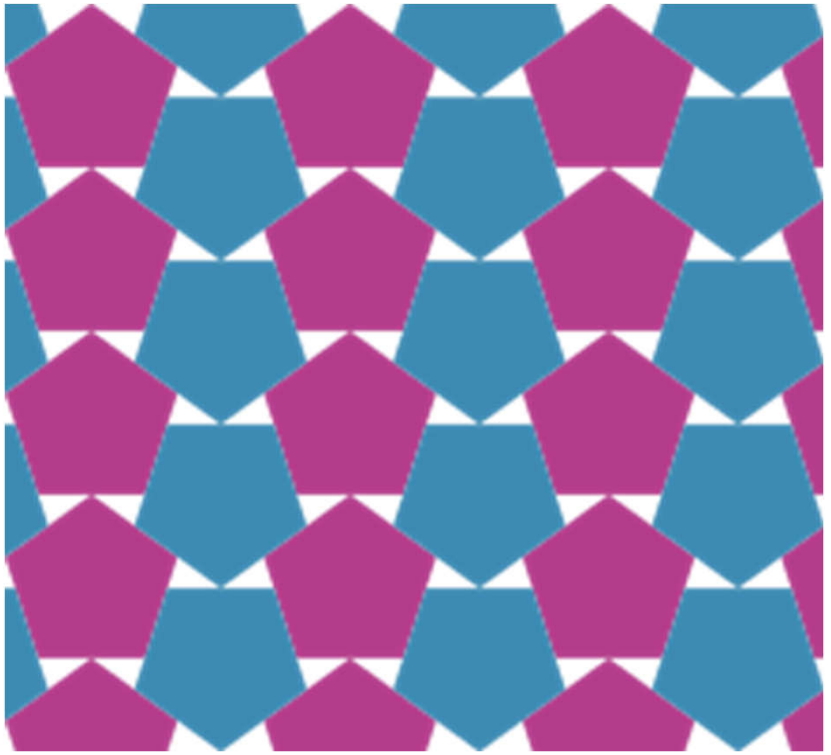
https://upload.wikimedia.org/wikipedia/commons/thumb/9/96/Regular_Pentagon_Using_Carlyle_Circle.gif/220px-Regular_Pentagon_Using_Carlyle_Circle.gif

$$D = \frac{1+\sqrt{5}}{2}\, t$$

https://en.wikipedia.org/wiki/Pentagon#/media/File:01-Pentagon-Euklid_Animation.gif

Il problema del piastrellista

A regular pentagon cannot appear in any tiling of regular polygons. First, to prove a pentagon cannot form a regular tiling (one in which all faces are congruent, thus requiring that all the polygons be pentagons), observe that 360° / 108° = 31⁄3 (where 108° Is the interior angle), which is not a whole number; hence there exists no integer number of pentagons sharing a single vertex and leaving no gaps between them. More difficult is proving a pentagon cannot be in any edge-to-edge tiling made by regular polygons:
The maximum known packing density of a regular pentagon is approximately 0.921, achieved by the double lattice packing shown. In a preprint released in 2016, Thomas Hales and Wöden Kusner announced a proof that the double lattice packing of the regular pentagon (which they call the "pentagonal ice-ray" packing, and which they trace to the work of Chinese artisans in 1900) has the optimal density among all packings of regular pentagons in the plane.[15] As of 2020, their proof has not yet been refereed and published.



Il pentagono in natura

Plants [edit]

Pentagonal cross-section of okra.

Morning glories, like many other flowers, have a pentagonal shape.

The gynoecium of an apple contains five carpels, arranged in a five-pointed star

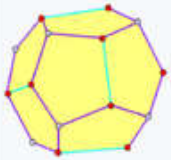
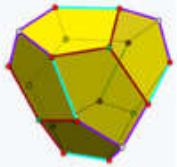
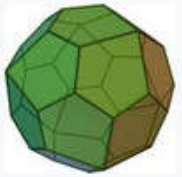
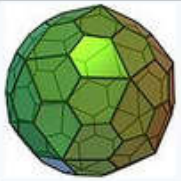
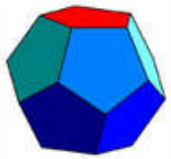
Animals [edit]

A sea star. Many echinoderms have fivefold radial symmetry.

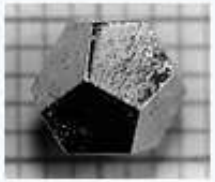
Another example of echinoderm, a sea urchin endoskeleton.

An illustration of brittle stars, also echinoderms with a pentagonal shape.

Pentagons in polyhedra [edit]

I_h	T_h	T_d	O	I	D_{5d}
					
Dodecahedron	Pyritohedron	Tetartoid	Pentagonal icositetrahedron	Pentagonal hexecontahedron	Truncated trapezohedron

Minerals [edit]



A Ho-Mg-Zn icosahedral quasicrystal formed as a pentagonal dodecahedron. The faces are true regular pentagons.

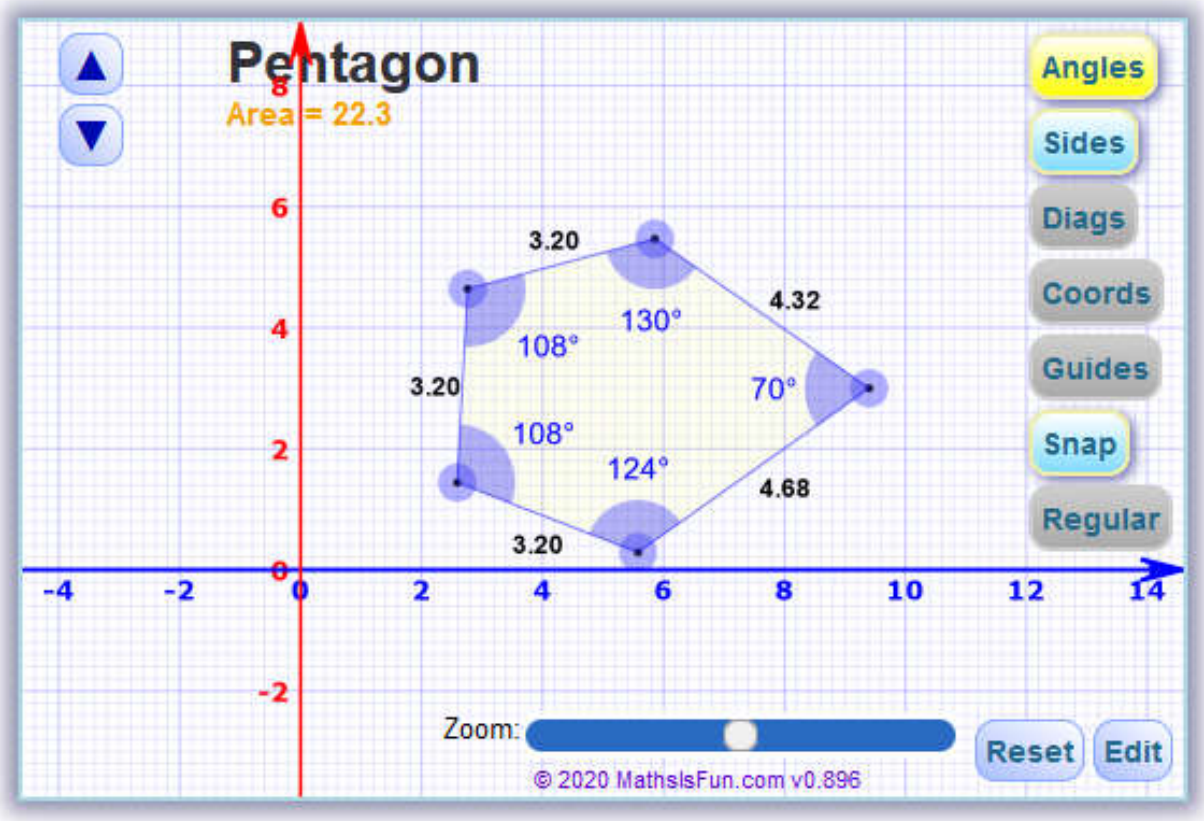
A pyritohedral crystal of pyrite. A pyritohedron has 12 identical pentagonal faces that are not constrained to be regular.

https://en.wikipedia.org/wiki/Pentagon

Math is Fun

Can you draw your polygon? Maybe you know the coordinates, or lengths and angles, either way this can give you a good **estimate** of the Area.

Note: due to computer rounding errors the last digit is not always correct.



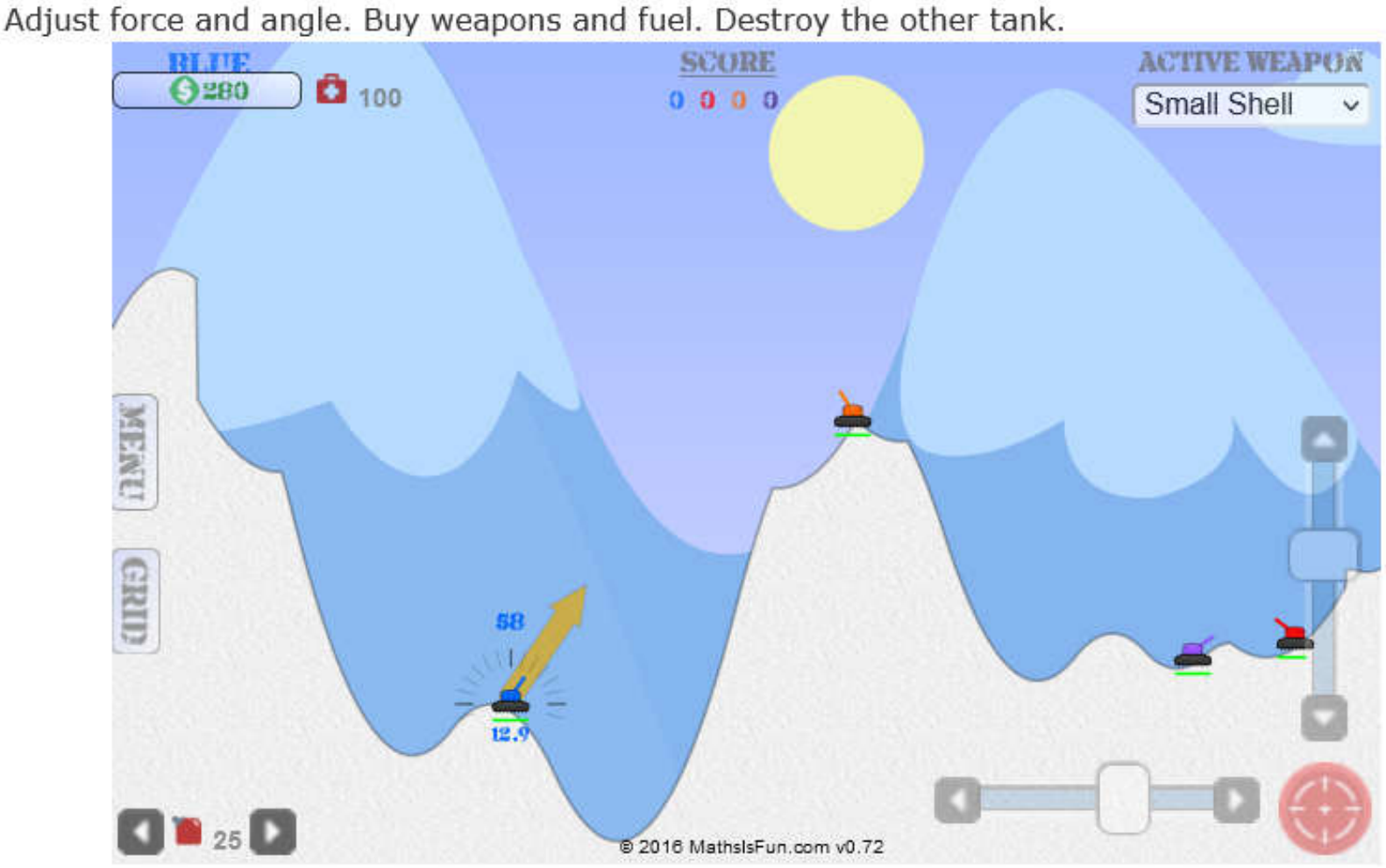
Edit https://www.mathsisfun.com/geometry/area-polygon-drawing.html

Use the "Edit" button to manually edit the coordinates, or to **enter new coordinates of your own**

Math is Fun

https://www.mathsisfun.com/

Math is Fun: la battaglia di carri armati



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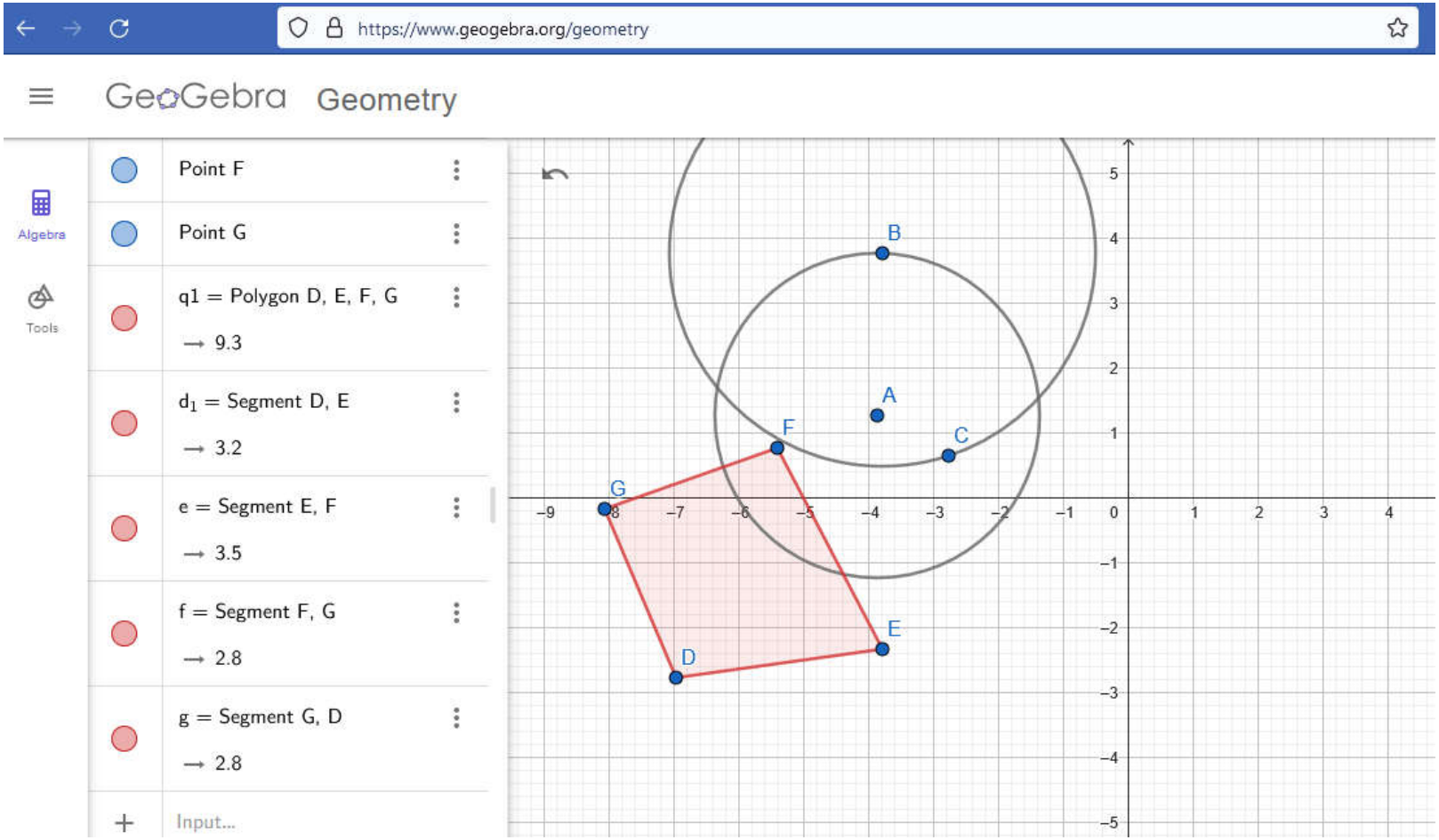
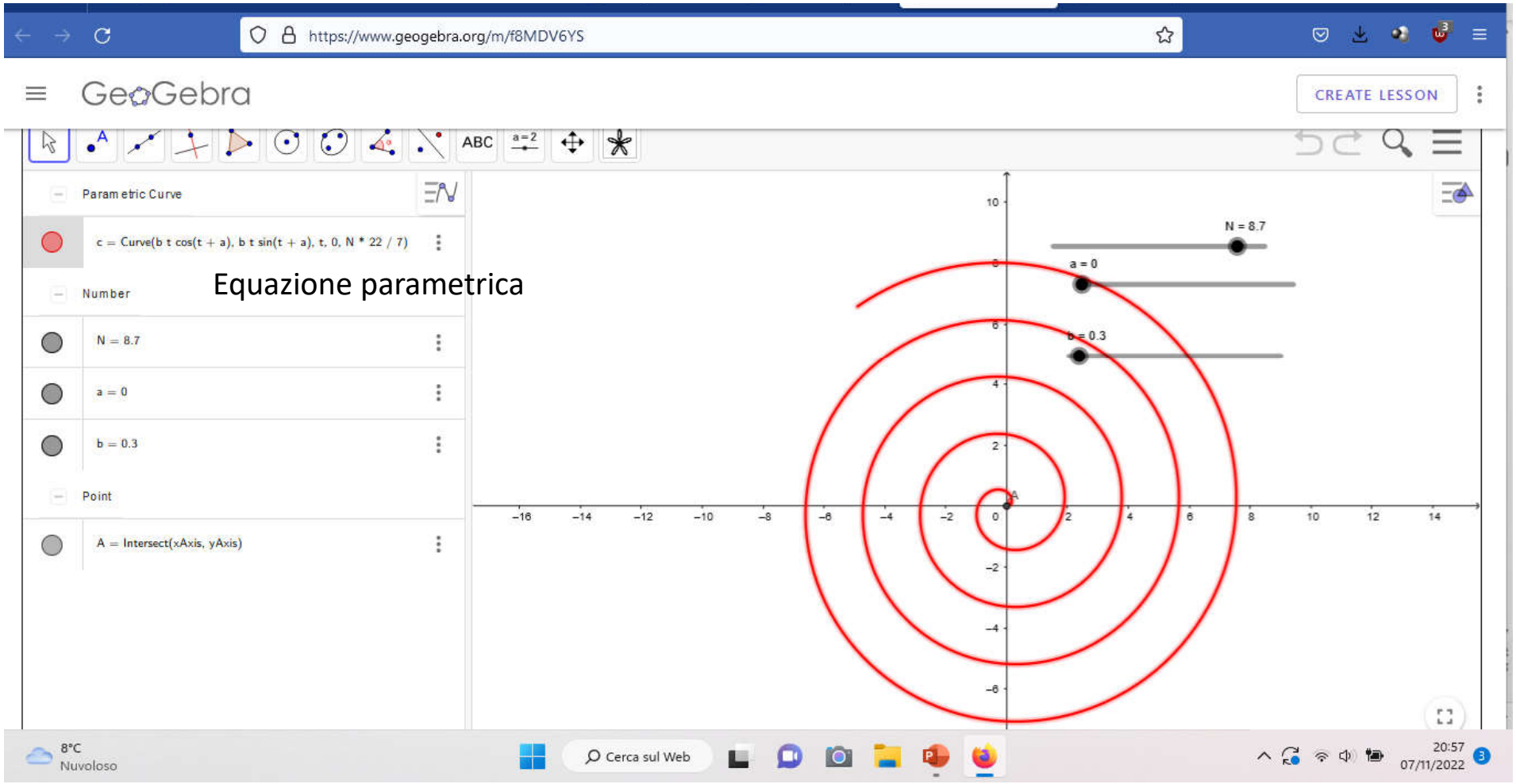


Lo strumento didattico serio: Geogebra



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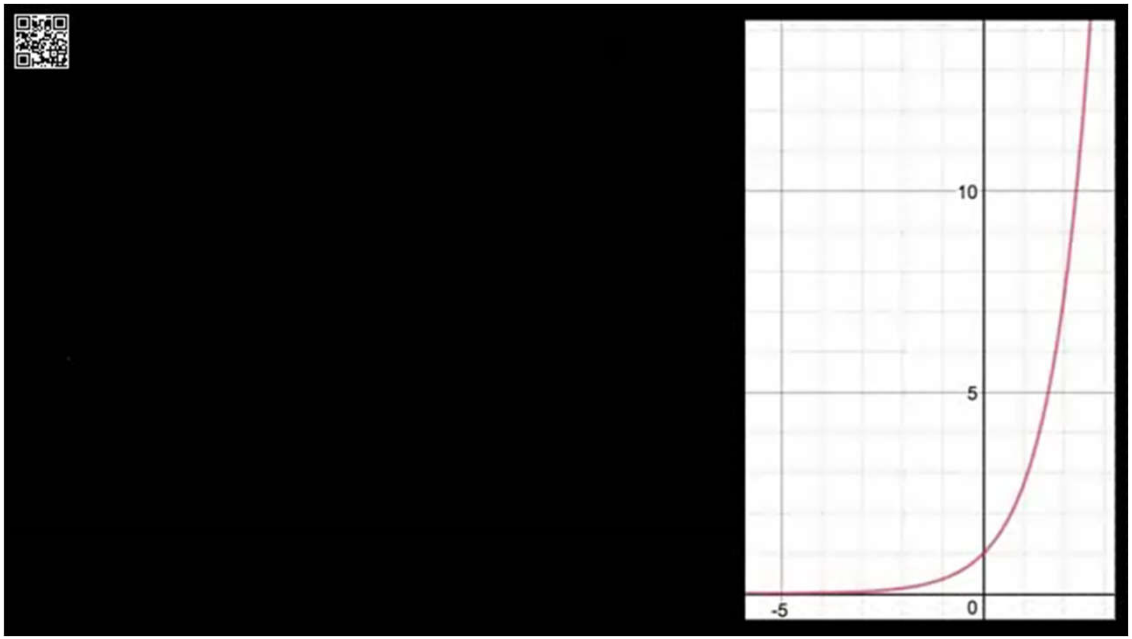

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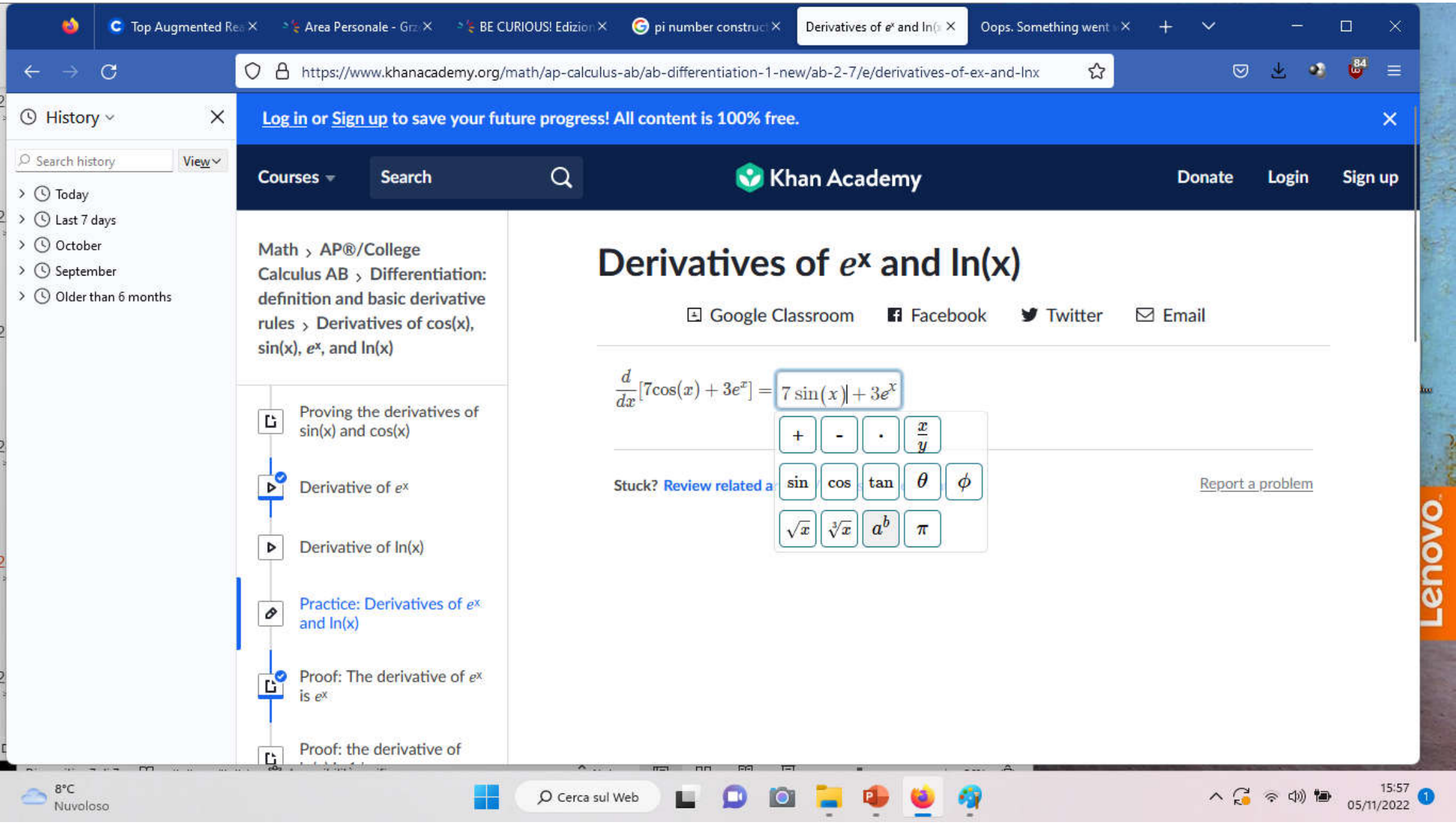
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Proving the derivatives of sin(x) and cos(x)
Derivative of e^x
Derivative of ln(x)
Practice: Derivatives of e^x and ln(x)
Proof: The derivative of e^x is e^x
Proof: the derivative of
Derivatives of e^x and ln(x)
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d/dx[7cos(x) + 3e^x] = 7 sin(x) + 3e^x
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Derivatives of e^x and ln(x)

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$$\frac{d}{dx}[7\cos(x)+3e^x] = \boxed{-7\sin(x)+3e^x}$$

1 / 3

Recall that $\frac{d}{dx}[e^x] = e^x$ and $\frac{d}{dx}[\cos(x)] = -\sin(x)$.

+ Get another hint (1/3)

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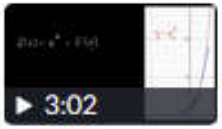

Derivative of e^x

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Next lesson
The product rule

Derivatives of e^x and ln(x)

$$\frac{d}{dx}[-\ln(x)+x^2] = \boxed{-\frac{1}{x}+2x}$$

1 / 3 Recall that $\frac{d}{dx}[\ln(x)] = \frac{1}{x}$ and $\frac{d}{dx}[x^n] = nx^{n-1}$.

2 / 3

$$\frac{d}{dx}[-\ln(x)+x^2]$$

$$= -1 \cdot \frac{d}{dx}[\ln(x)] + \frac{d}{dx}[x^2]$$

$$= -1 \cdot \frac{1}{x} + (2x^1)$$

$$= -\frac{1}{x} + 2x$$

3 / 3 **In conclusion,**

$$\frac{d}{dx}[-\ln(x)+x^2] = -\frac{1}{x}+2x$$

Math › AP®/College Calculus AB › Differentiation: definition and basic derivative rules › Derivatives of cos(x), sin(x), e^x, and ln(x)

Proving the derivatives of sin(x) and cos(x)
Derivative of e^x
Derivative of ln(x)
Practice: Derivatives of e^x and ln(x)
Proof: The derivative of e^x is e^x
Proof: the derivative of ln(x) is 1/x

Proof: The derivative of e^x is e^x

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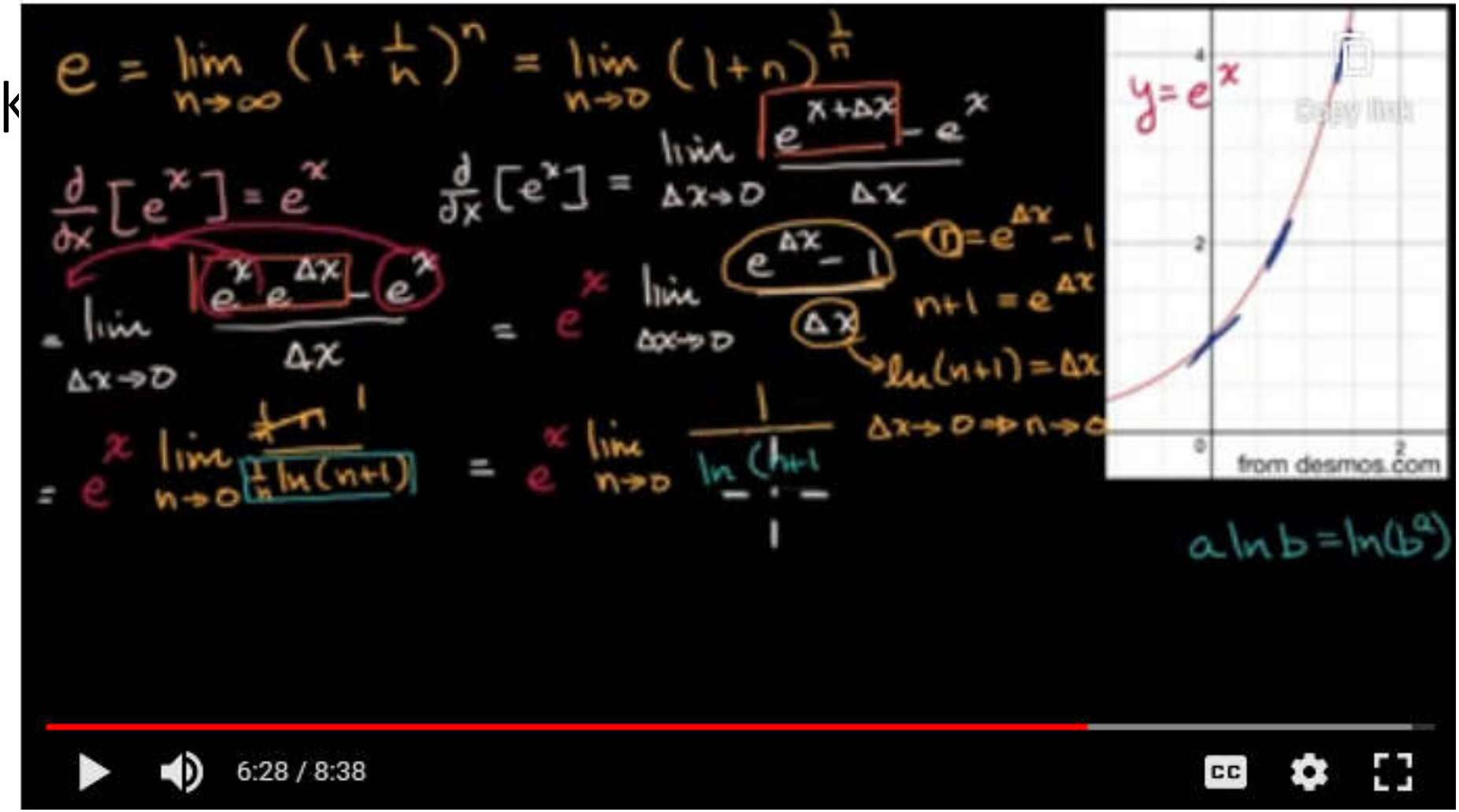
e^x is the only function that is the derivative of itself!

$$\frac{d}{dx}[e^x] = e^x$$

(Well, actually, $f(x) = 0$ is also the derivative of itself, but it's not a very interesting function...)

The AP Calculus course doesn't require knowing the proof of this fact, but we believe that as long as a proof is accessible, there's always something to learn from it. In general, it's always good to require some kind of proof or justification for the theorems you learn.



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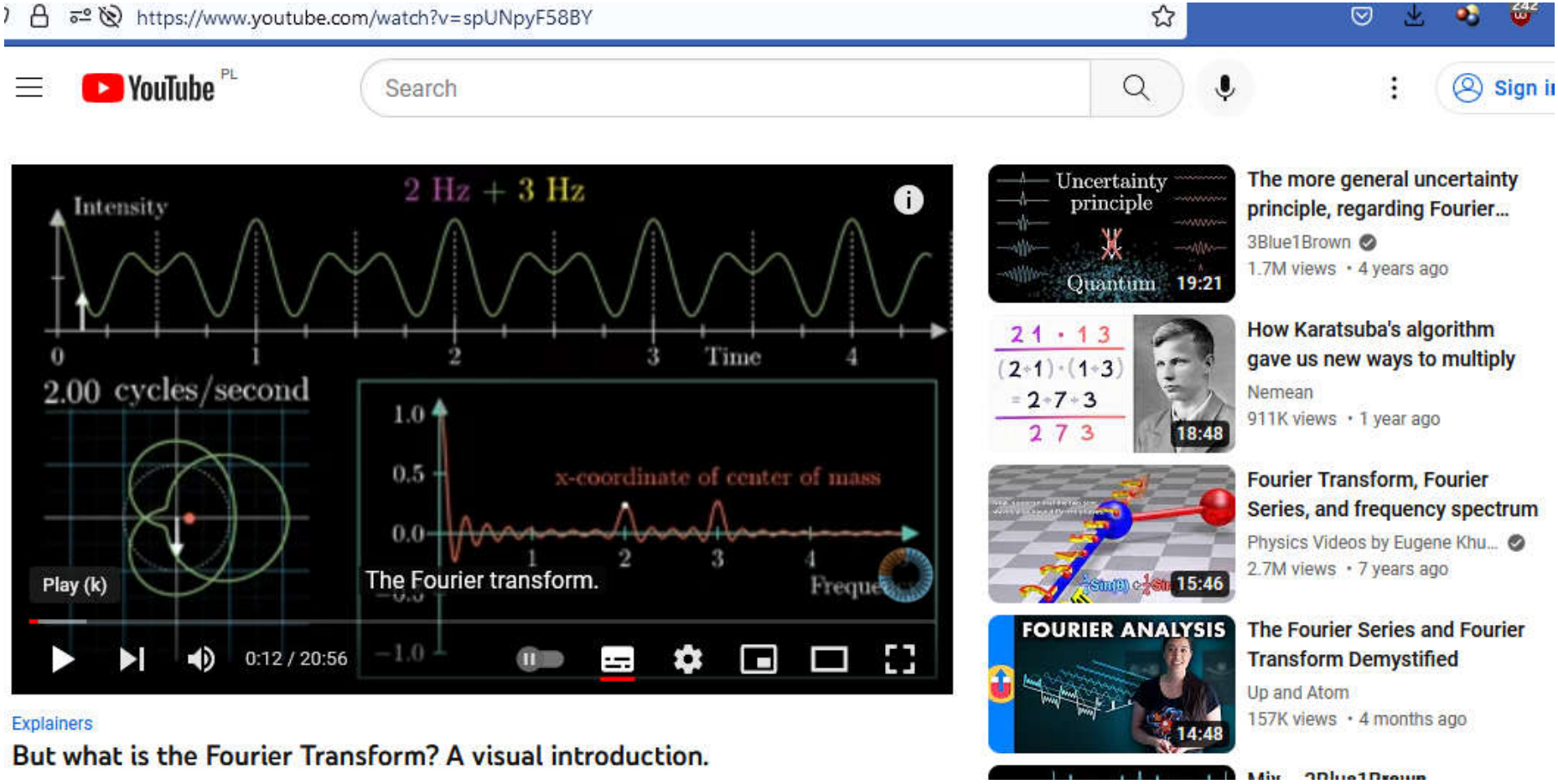

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per es. «cerchiamo i divisori del 48»

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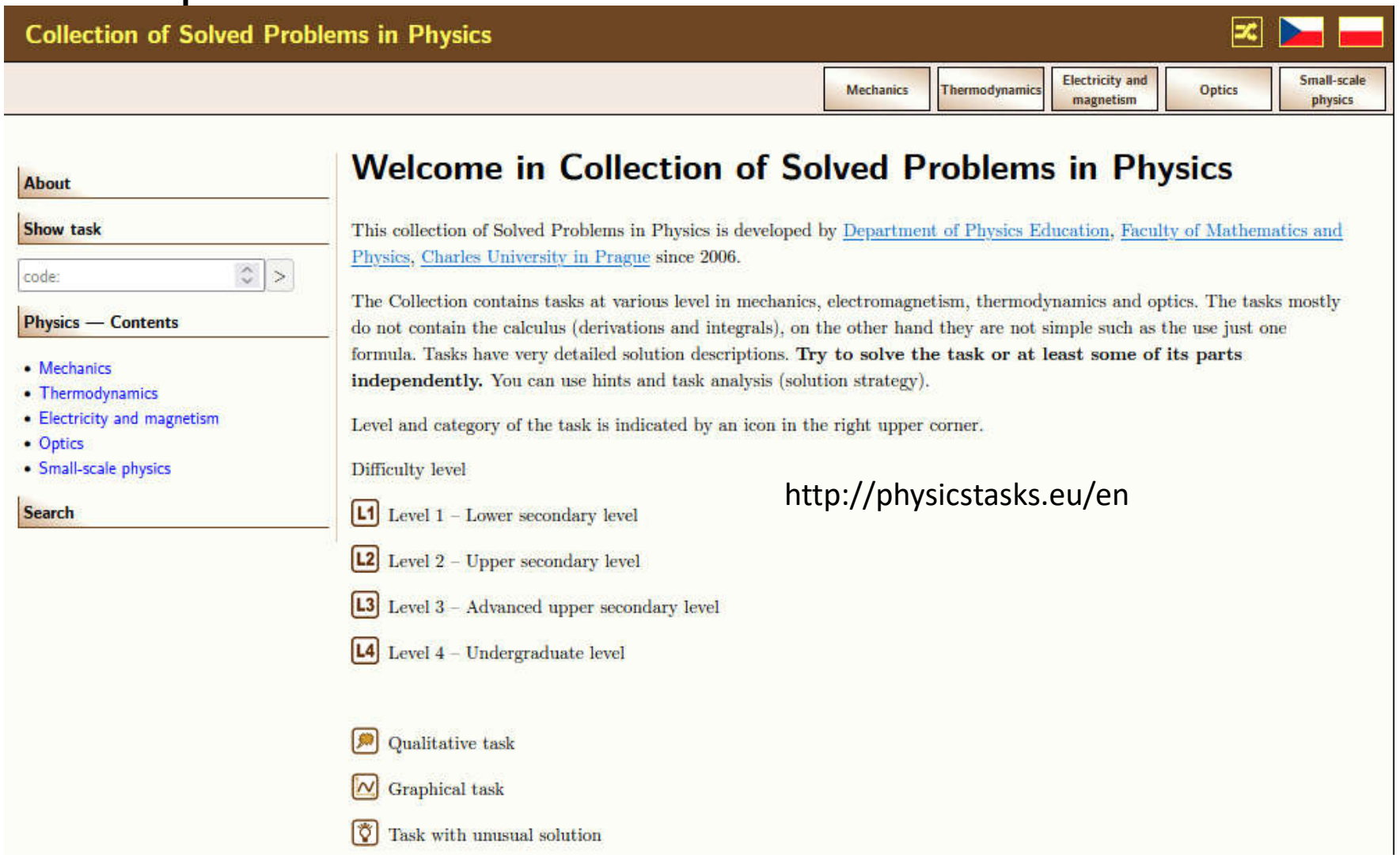

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- **Kinematics of mass point** (30)
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  - A lift (L2)
  - Annie's Ride (L1)
  - Passing of a train I (L1)
  - Passing of a train II (L1)
  - Moving Boat (L2)
  - **Rescue Plane** (L2)
  - Rolling of a Ball (L2)
  - Basketball player (L2)
  - A garden hose (L3)
  - Water streaming out of the tank (L3)
  - A Cannon Firing Down a Hill (L4)
  - Cottage Dwellers (L2)
  - The Voyage of a Raft (L3)
  - Mouse and Cat (L3)
  - Sliding of a Line Segment I (L3)
  - An ant on a rod (L4)
  - A ladybug crawling on a rotating cylinder (L4)
  - Movement of a Particle I (L4)

Rescue Plane

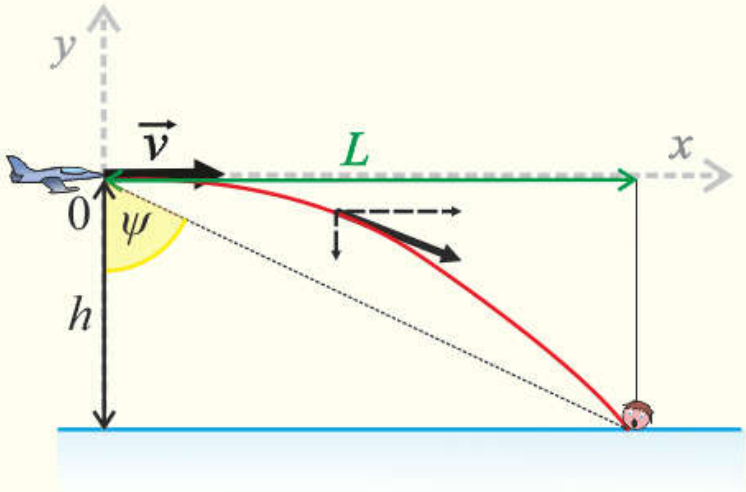
Task number: 1992

L2 RU

A rescue plane flies to help a drowning man. The pilot keeps the plane at a constant height of 1200 m above the water surface and heads directly above the man's head (see the diagram). The speed of the plane is 430 $\mathrm{km \cdot h^{-1}}$.

At what angle of view must the pilot release the rescue bag in order to let it fall as close to the man as possible?

Neglect the resistance of environment.



http://physicstasks.eu/

Given values

$h = 1200$ m	height of the plane above the water surface
$v = 430$ km · h^{-1}	speed of the plane
$\psi = ?$ (°)	angle of view
From the tables:	
$g = 9.81$ m · s^{-2}	gravitational acceleration

Hint 1: Initial velocity of the bag

What is the initial velocity of the bag? Do you know its magnitude?

Solution of Hint 1

The initial velocity of the bag is identical to the velocity of the plane. Therefore it has the magnitude v.

Hint 2: Duration of the fall on the surface

What is the motion of the bag in a vertical direction?

How can you determine the time t it takes before the bag hits the water surface if you know at what height h above the surface it was released?

Solution of Hint 2

If we neglect the resistance of environment, the bag moves vertically in a free fall.

Because we know at what height it was released, we can easily determine the duration of its fall to the surface. It holds in the direction of the y axis that:

$$-h = -\frac{1}{2}gt^2,$$

therefore:

wolfram.com

geometria

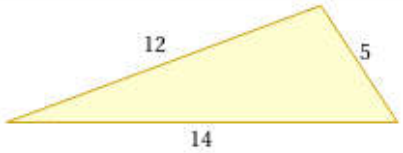
Assuming "triangle" is a geometric object | Use as a unit instead

Input interpretation

triangle | edge lengths 5 | 12 | 14

https://www.wolframalpha.com/input?i=5%2C+12%2C+14+triangle

Visual representation



Triangle shape

obtuse triangle

Properties

Less | Step-by-step solution

circumradius	$\frac{40}{\sqrt{31}} \approx 7.18421$
inradius	$\frac{21}{2\sqrt{31}} \approx 1.88586$
area	$\frac{21\sqrt{31}}{4} \approx 29.2308$
perimeter	31

wolframalpha:

Persino
la geografia

https://www.wolframalpha.com/input?i=France

Satellite image »

Geographic properties

Enlarge | Data | Customize | Sources

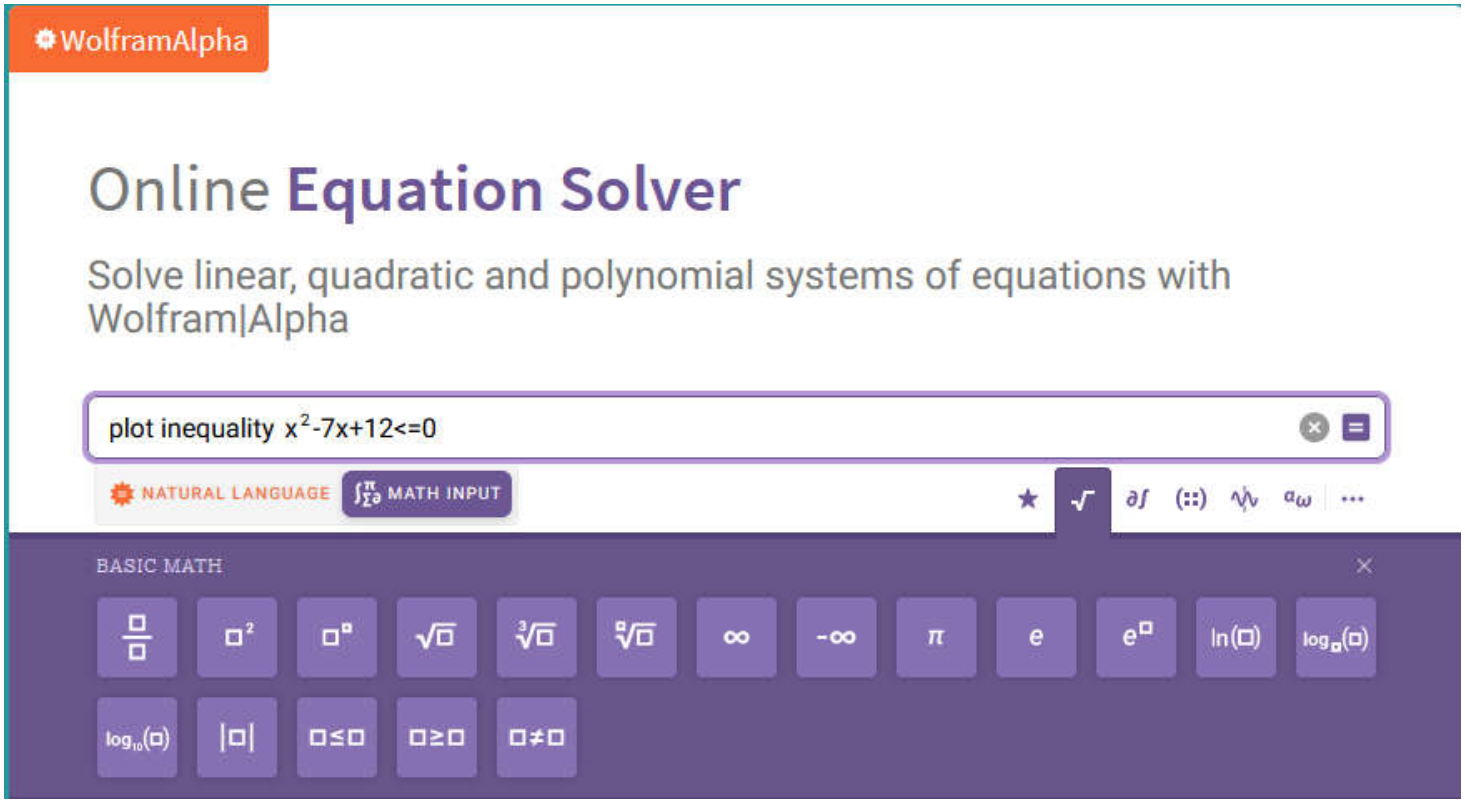
total area	551 500 km^2 (square kilometers) (world rank: 49th)
land area	549 970 km^2 (square kilometers) (world rank: 49th)
continent	Europe

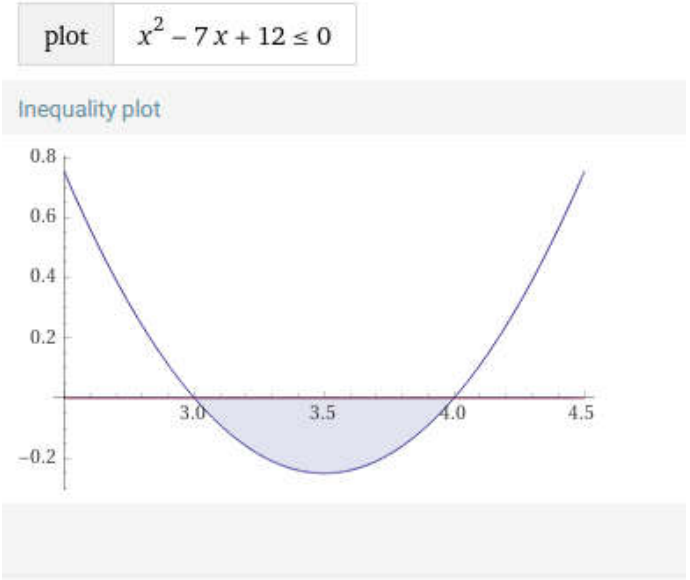
annual-crop land fraction	33.1% (world rank: 25th)
natural resources	antimony | arsenic | bauxite | coal | feldspar | fish | fluorspar | gypsum | iron | potash | timber | uranium | zinc | petroleum | kaolin | niobium | tantalum | clay
coastline length	3427 km (kilometers) (world rank: 36th)
highest point	4808 meters (Mont Blanc (mountain))

Modello della scavatrice, con tanto di ricambi

https://www.mathematica.pl/?wolfram-systemmodeler,251

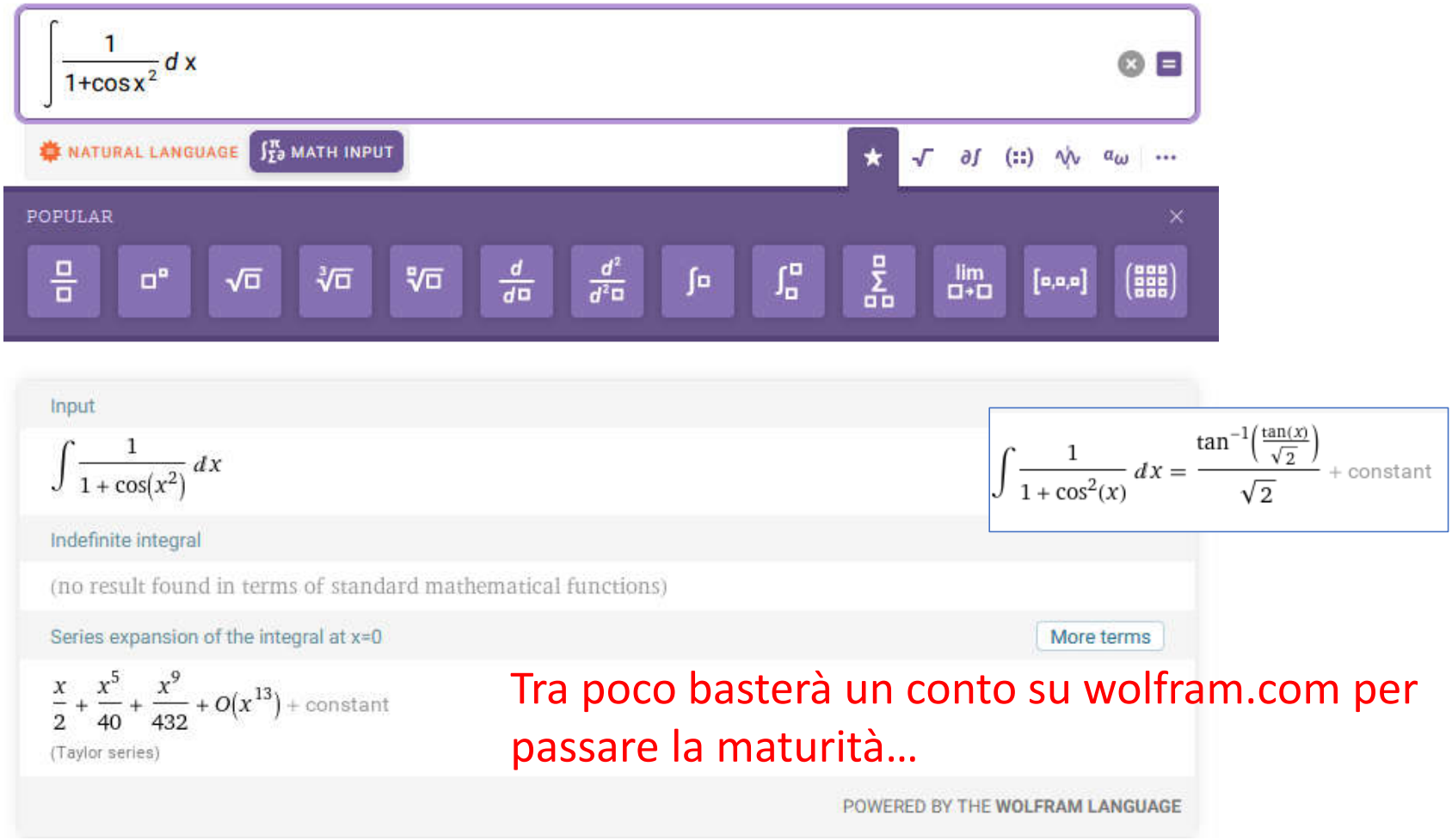
On-line equation solver





https://www.wolframalpha.com/calculators/equation-solver-calculator

On-line equation solver

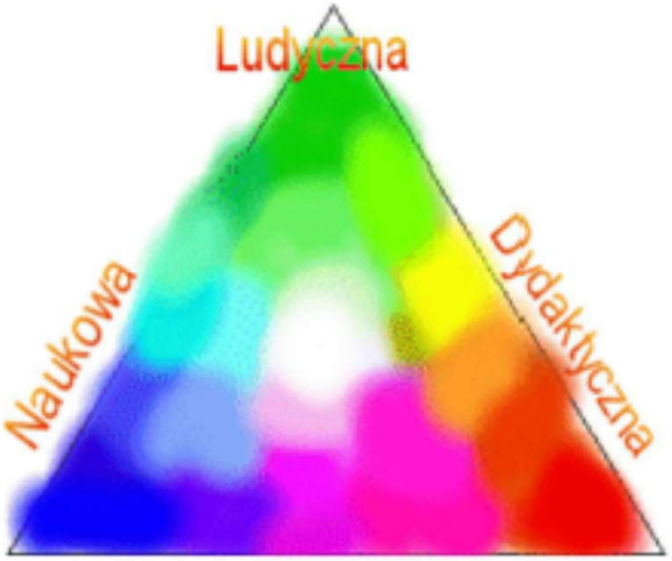


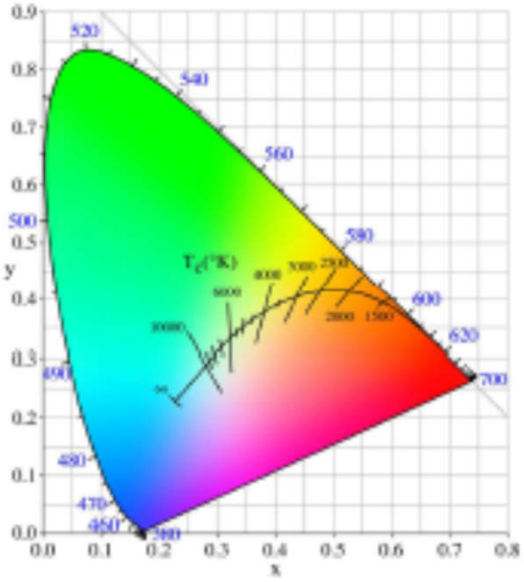
Tra poco basterà un conto su wolfram.com per passare la maturità…

Il riassunto

- La matematica è, senza dubbio, utile, ma può essere in ugual modo *dilettevole*
- Un arduo compito (per l'insegnante, il ministero che definisce cv, gli editori) di trovare un giusto equilibrio, che unisca la didattica, il divertimento, e la scienza

Grazie per la vostra attenzione!





G. Karwasz, J. Kruk *Idee ed implementazioni della didattica interattiva,* UMK, Torun, 2011