

Symmetry - Beauty - Truth

Since the dawn of time, the human being has been looking for **regularities**: to calm anguish and fears



Symmetry - Beauty - Truth

Regularities like the heartbeat, the alternation of day and night, the lunar cycles, the seasons, the rites



Symmetry - Beauty - Truth

On another side
surviving required the
ability to distinguish
edible from poisonous
and dangerous from
non-dangerous



Symmetry - Beauty - Truth

J.D. Barrows wrote:

“Perhaps all the basic of all [...] is an ability to sense and classify **patterns**”

The Artful Universe,
Oxford Press, 1995

https://en.wikipedia.org/wiki/John_D._Barrow

Symmetry - Beauty - Truth

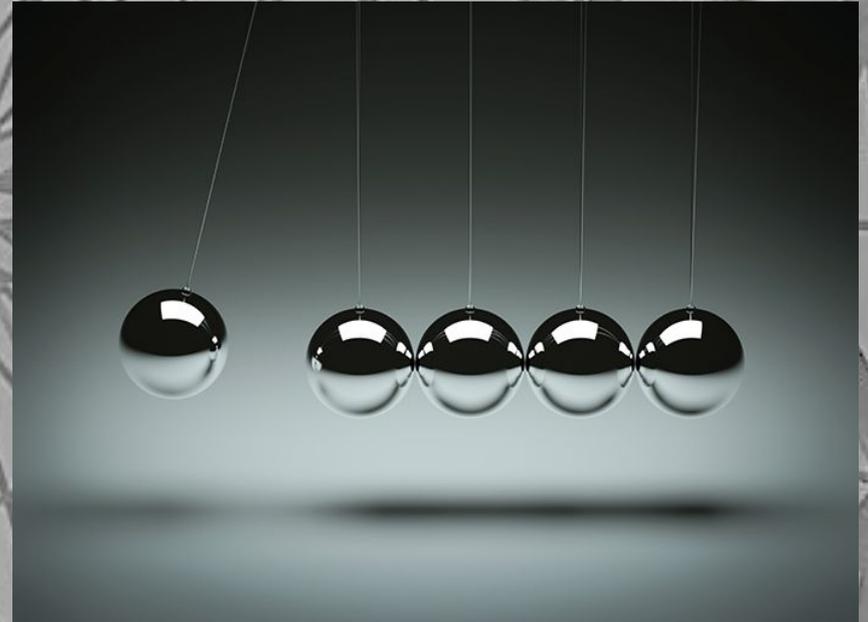
On another side still
when our knowledge is
young we consider
regularity relaxing and
symmetry **beautiful**.

[Then we grow up...]



Symmetry - Beauty - Truth

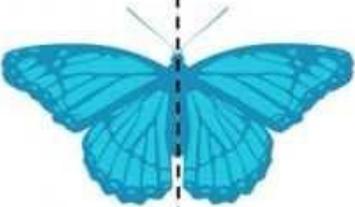
But the idea that natural phenomena follow a **principle of symmetry** characterizes important results in both classical and modern physics



Symmetry - Beauty - Truth

I.E. Noether's Theorem
ascribes all laws of
conservation to symmetry.
And Maxwell and Einstein
results express a
'symmetry need'

Noether's Theorem
Line Symmetry



Noether's Theorem says if a system has a continuous symmetry, then there must be corresponding quantities whose values are conserved.



Emmy Noether
1882 - 1935

Symmetry - Beauty - Truth

In conclusion

(provisional): symmetries

intertwine two of the

essential threads of

research for humans:

that of **beauty**

that of **truth**

Symmetry - Beauty - Truth

Today I'll propose a path for the first or second year of high school involving the following subjects:

art

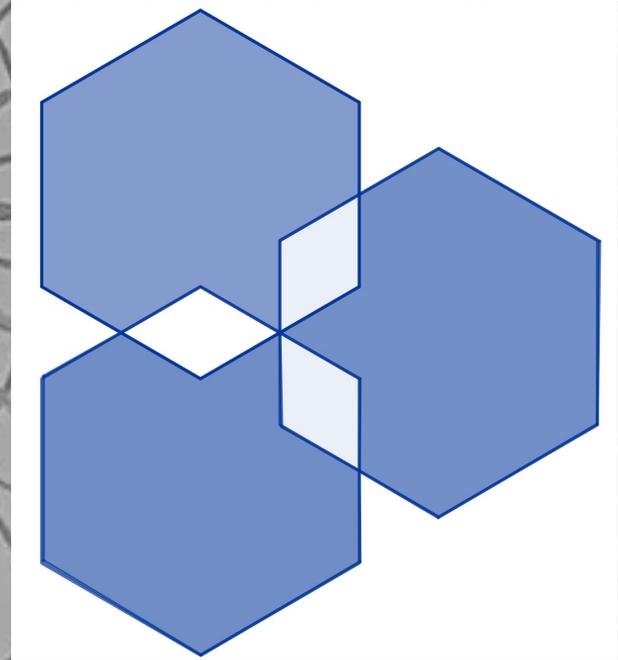
physics

mathematics

literature

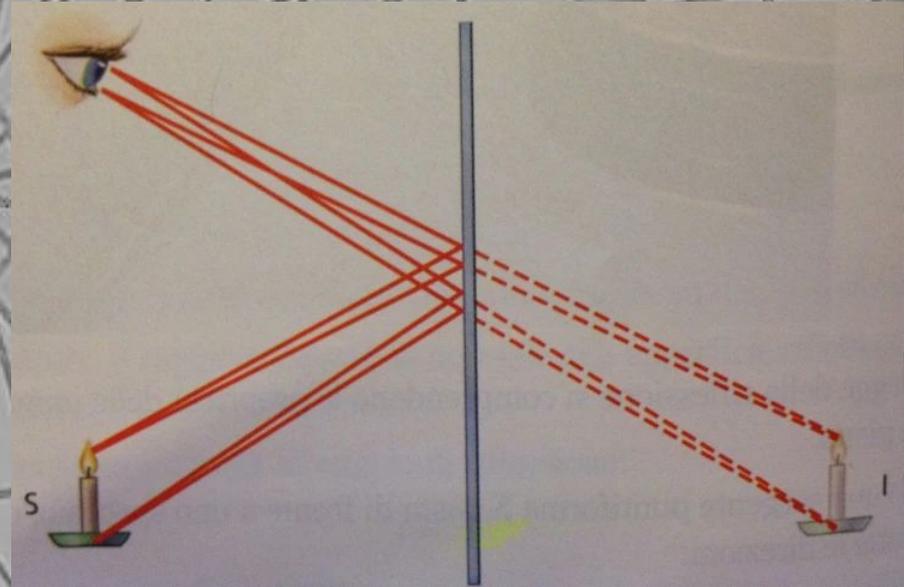
Patterns in islamic ART

In the app Geogebra (GGB) we'll use the instruments of "reflected object in line / in point" to reproduce patterns



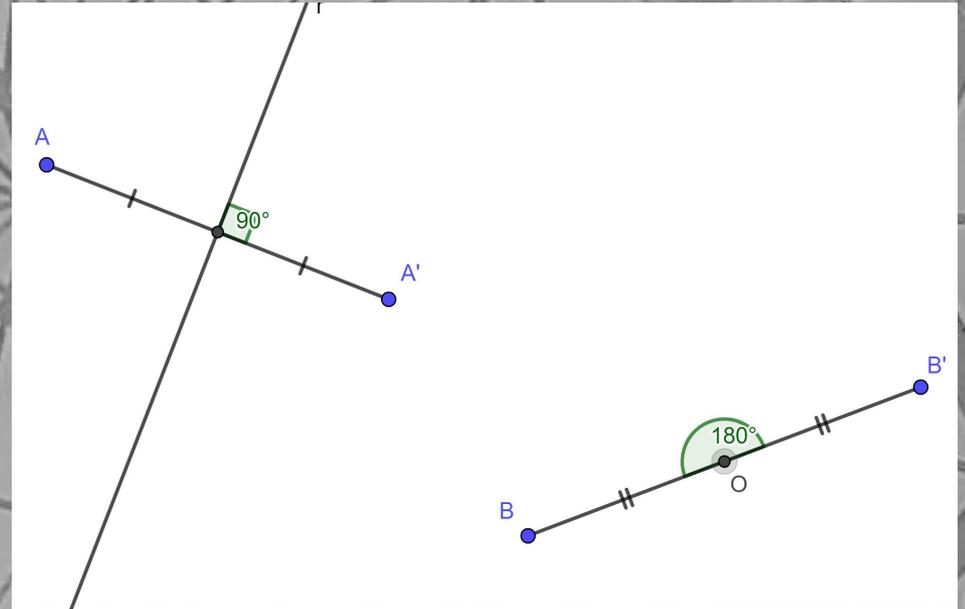
PHYSICS: reflection laws

We'll examine
reflection laws and
how virtual images
are formed



MATHEMATICS definitions

We'll talk about
axial and **central**
symmetry and how
introduce it to
students



LITERATURE: quatrains

Visual poetry and
quatrains offers
interesting
examples of
symmetries

- A Tonight I see you float across the room.
- B My palms do sweat, and I can feel you glow.
- A Our eyes might meet, and then my heart will bloom.
- B My love for you, a never ending flow.
- C You touch my hand, and I try not to shake.
- D The way you make me feel is like a dream.
- C And in that dream my world is 'bout to quake,
- D Because you are my sun, my lovely gleam.

Let's go!



Anagni, cattedrale, quinconce

Patterns in islamic art

I taken
informations and
images from this
website:
patterninislamicart.com/

You can find also
materials for:
geography,
history, history of
religions

Patterns in islamic art

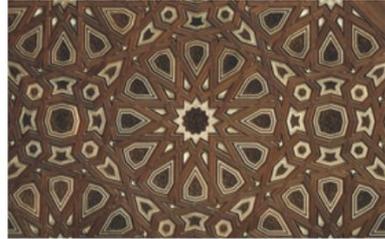
Strong limitations on reproducing human images led Islamic artists to create wonderful geometric ornaments

The enormous extension of the Islamic empire allows to find examples of this art in many parts of the world

Examples



General Survey



Egypt & Syria



India



Iran



Morocco



Spain



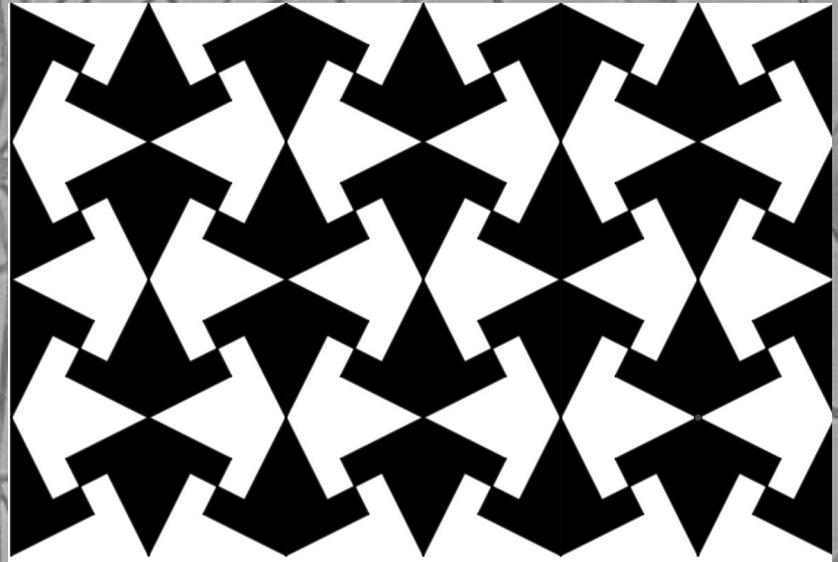
Transoxiana



Turkey

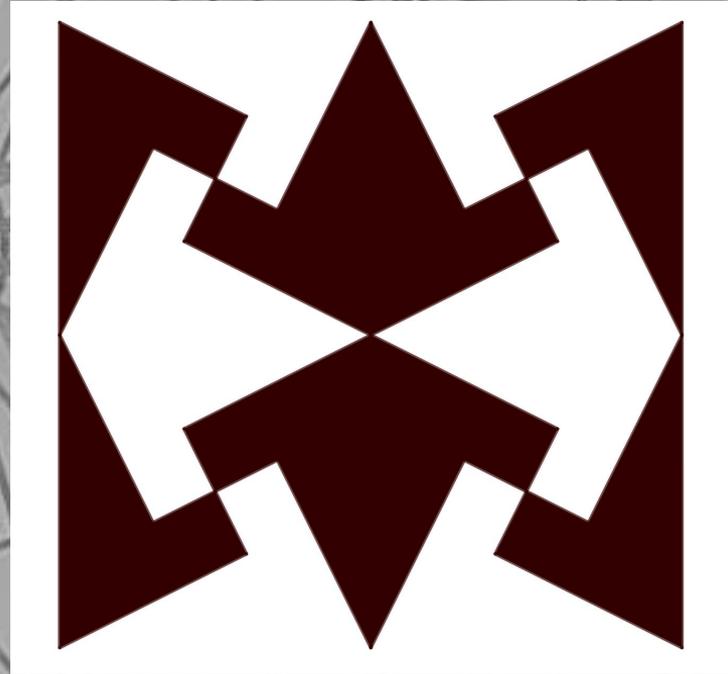
Patterns in islamic art

We'll see how to
remake this design that
I took from image
PIA022 of the website:
[patterninislamicart.com/image-
search?query=PIA022](http://patterninislamicart.com/image-search?query=PIA022)



Patterns in islamic art

We'll use the free
app [Geogebra](#) to
built together the
figure on the right
[Ready-made
construction at this [link](#)]



Patterns in islamic art

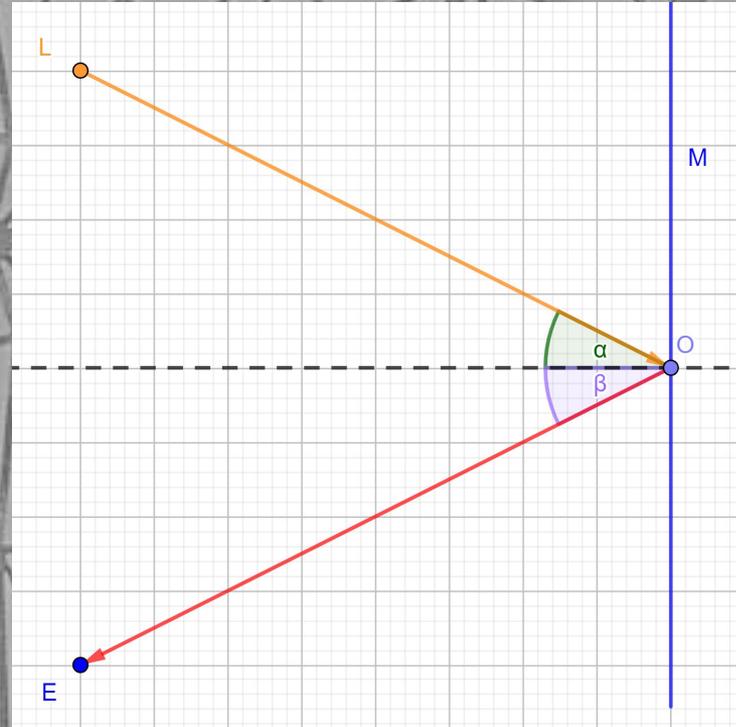
So, I propose to
start working with
symmetries without
defining them to
training students to
recognise them

As a reminder we used GGB
instruments:

- polygon
- reflection in line
- reflection in point

Physics: reflection laws

- 1) LO, n, OE stays in the same plane
- 2) $\alpha = \beta$
(incident angle and reflection angle are equals)



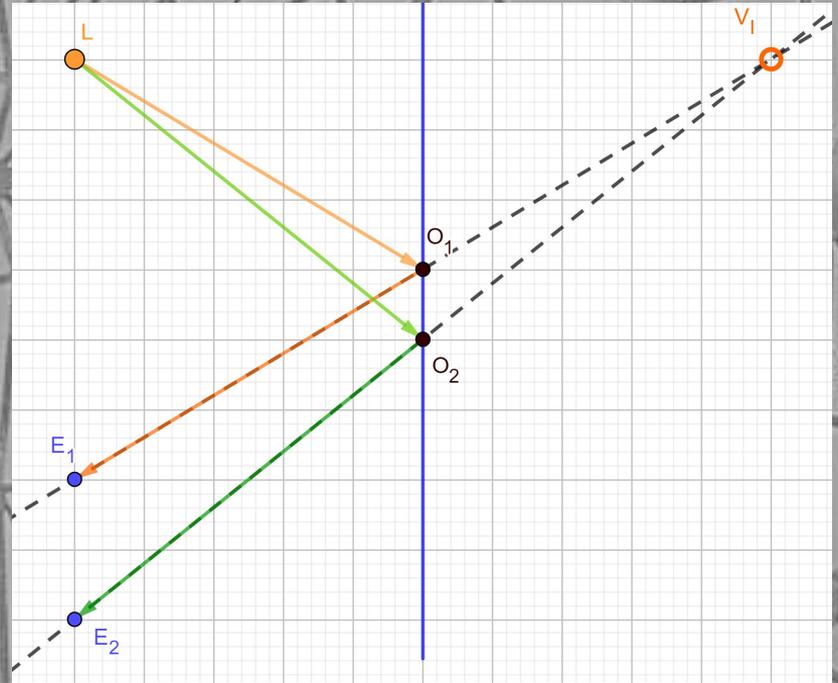
Physics: reflection laws

This short video (6 min) shows how students can verify the second law with an **experiment**; at school or at home

youtu.be/QZFfm05ZOek

Physics: virtual images

When two rays reflect
on the mirror and hit
our eyes our brain
prolong these rays until
the **virtual image** (VI)
inside the mirror



Physics: virtual images

In this video there is a mathematical proof that the **virtual image** is **symmetrical** to the **object** with respect to the mirror

youtu.be/7vXW8q8s1kA

I suggest you to show this video after discussing the mathematical definitions or after making an activity about this

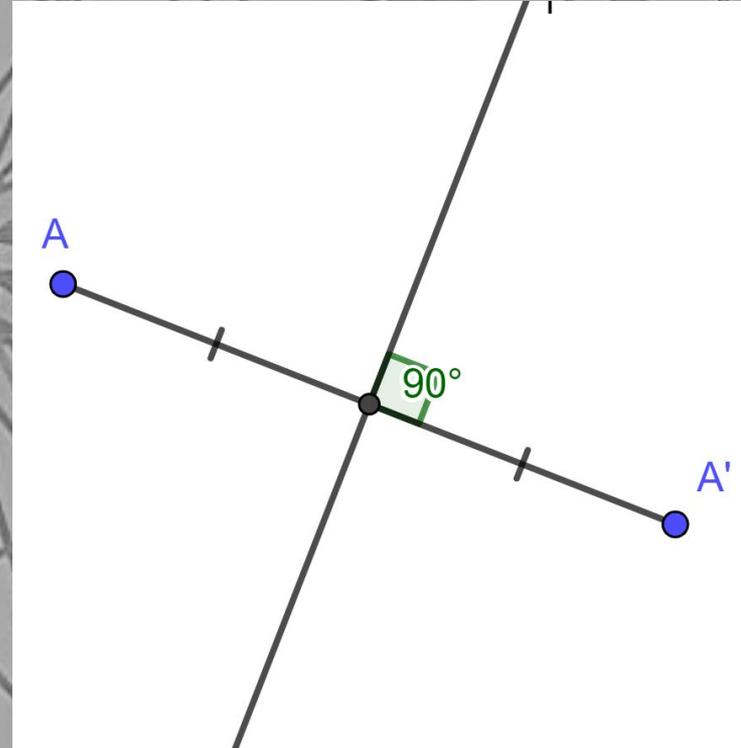
Mathematical definitions

In first activities students
used **symmetries** to
make drawings and
learned **recognizing** them
in physical phenomena

Starting from the
experiences they
made you can ask
them to try to **define**
symmetries

Axial symmetry

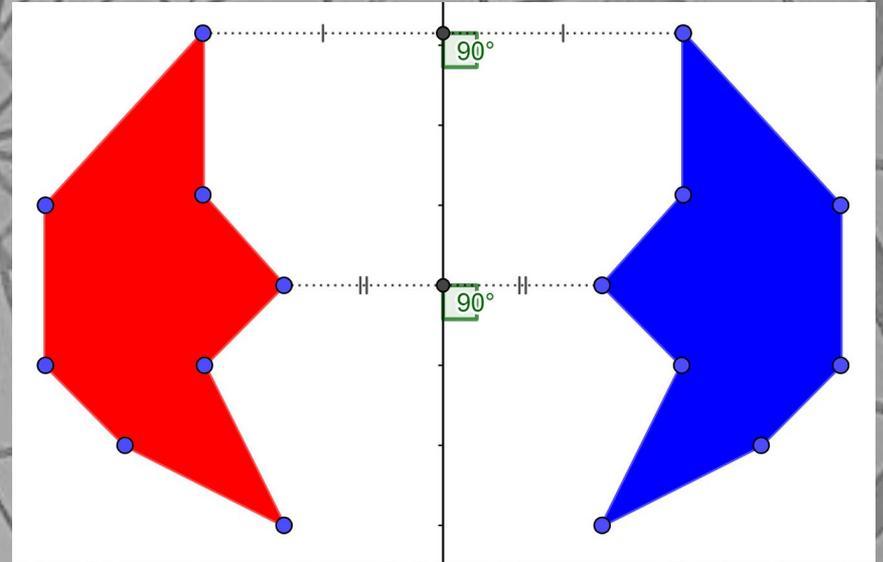
Two points A and A' are symmetrical to a line r if and only if r is the axis of segment AA'



Math: specular figures

Given a figure **RED** if I draw the symmetric pt of each pt with respect to the line r , I get a symmetric figure: **BLU**.

RED and **BLU** are specular



Math: symmetric figure

We defined **axial symmetry** between two points and two figures but we can find also **figures** that ARE **symmetric** with respect to a line

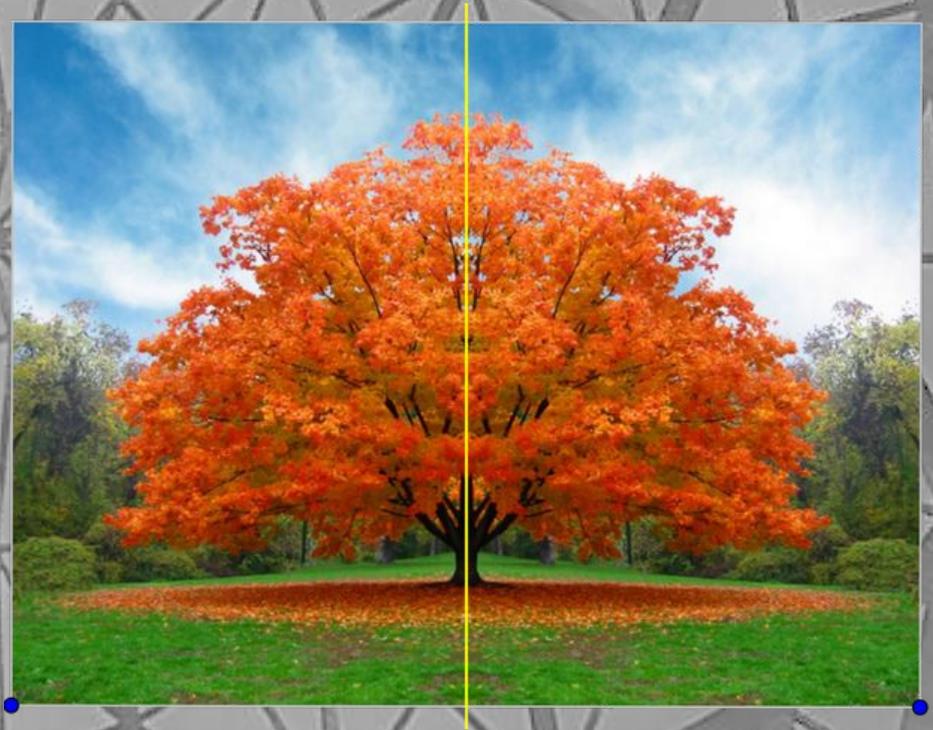
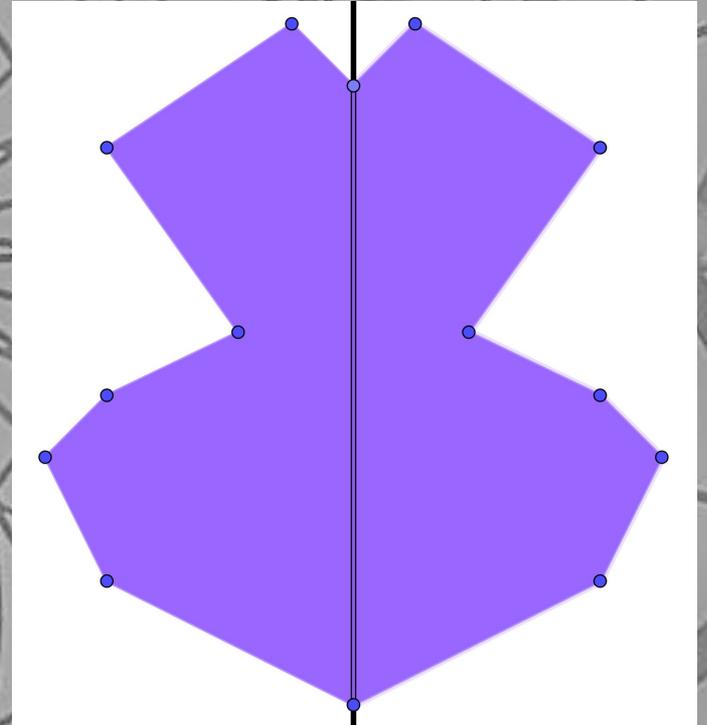


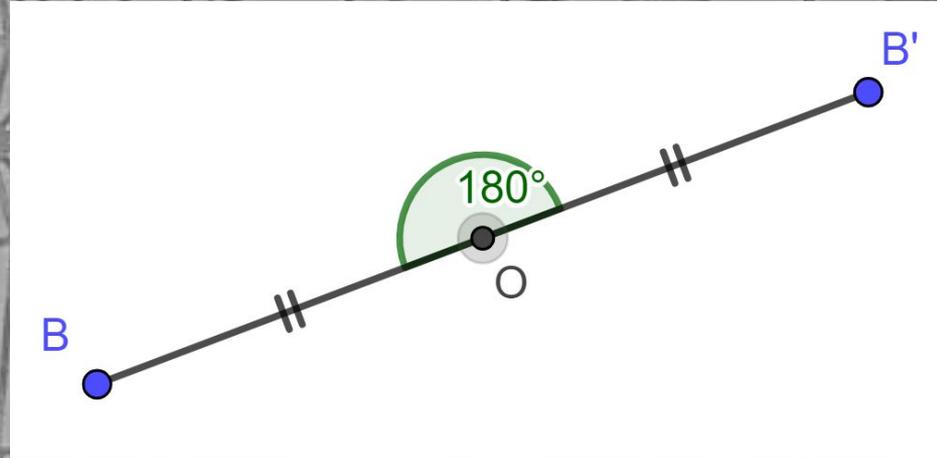
Figure symmetrical to a line

A figure is symmetrical to a line if this line divides it into two specular figures



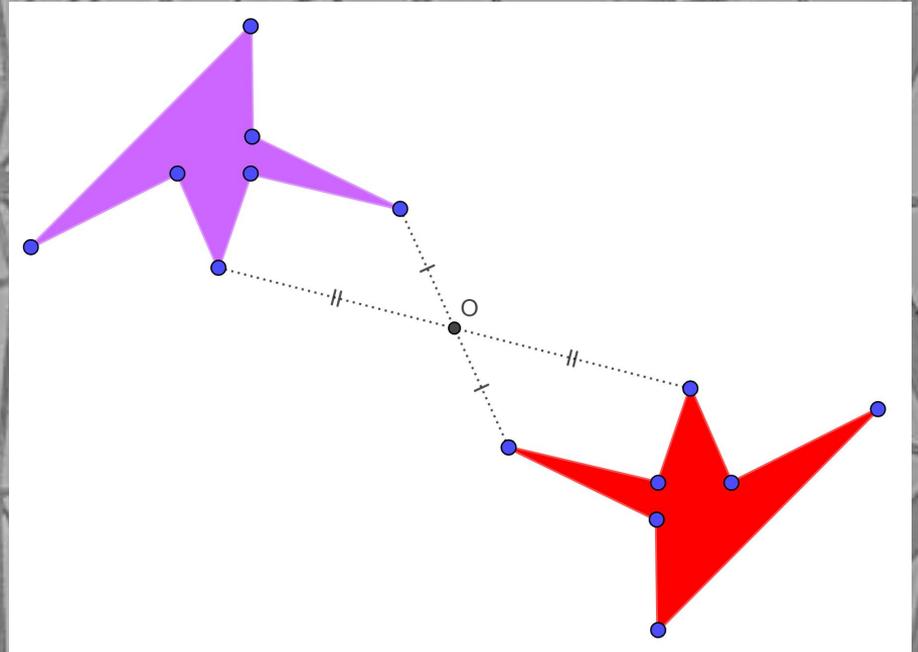
Central (point) symmetry

Two points B and B' are symmetrical to a third point O *if and only if* O is the mid-point of the segment BB'



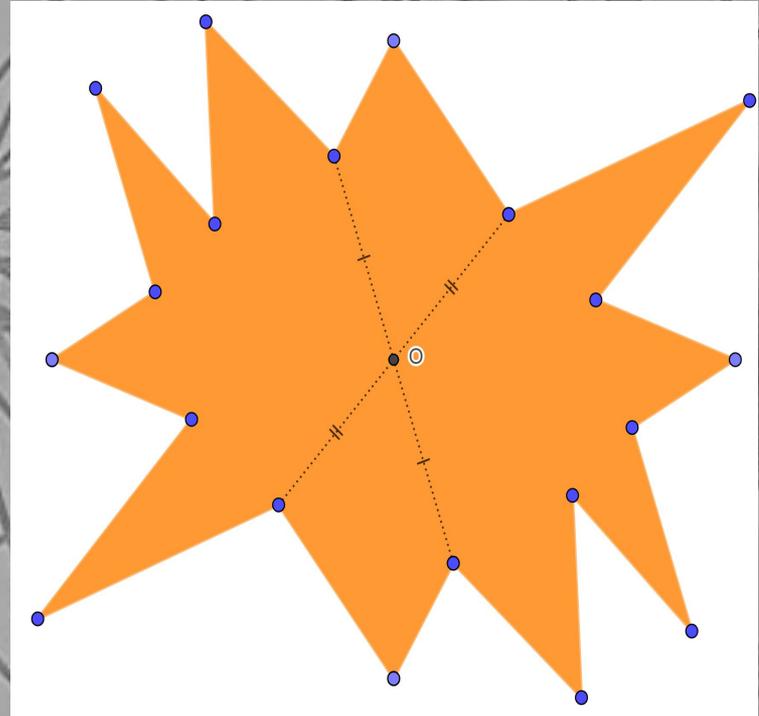
Math: 'opposites' figures

If I draw the symmetric
of each point of a figure
LILAC to a point O I get
a figure **RED** symmetric
of **LILAC** to O



And last but not least...

A **figure** is **symmetrical to a point** O if each pair of opposite points are symmetrical to that point

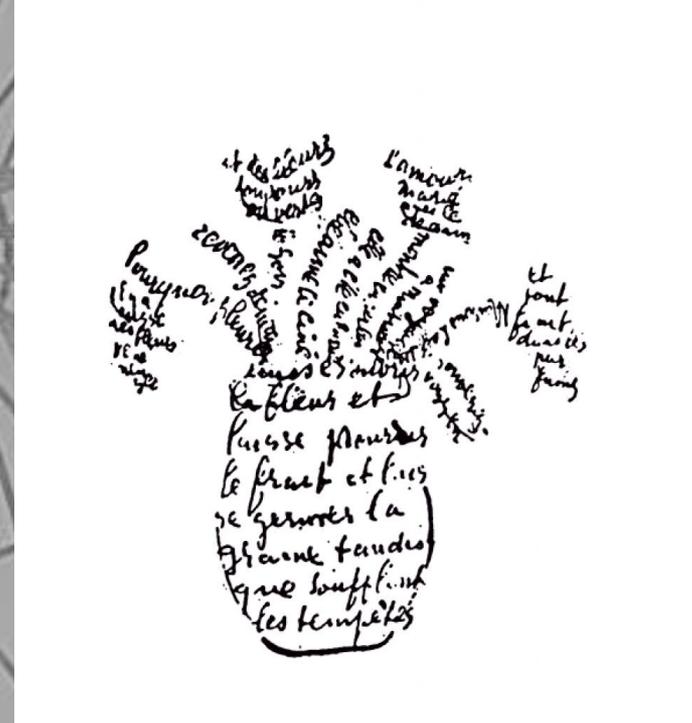


Literature: “visual poetry”

Thinking about
symmetry in literature
calligrams offers a lot
of possibilities of work

en.wikipedia.org/wiki/Calligramme

m



Literature: quatrains

But, to close our circle,
another proposal:
quatrains of Omar
Khayyam, connect
literature with islamic
art

Omar Khayyam was a
persian mathematician,
philosopher, astronomer
of XI century mentioned
in "*The parrot theorem*"
of Denis Guedij

Literature: quatrains

After doing research on Omar Khayyam and the Islamic art of the XI century you can proceed with a concrete activity

www.wikihow.com/Write-a-Quatrain-Poem

Circle closed!

IRA 0132



IRA 0133



IRA 0134



IRA 0135



IRA 0136



IRA 0137



IRA 0201



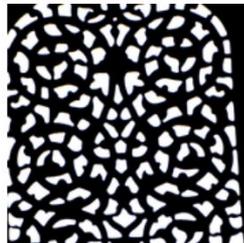
IRA 0202



IRA 0203



IRA 0204



IRA 0209



IRA 0212



If you want to go ahead...

ART: Cosmatesque floors, Gothic Rosettes, architectural elements, breaking of symmetries in contemporary art

PHYS: III dynamic principle, conservation of momentum, Gauss Theorem and applications; Maxwell equations; Relativity (of Galilei and Einstein); II TD principle

MATH: radial symmetry, circular reversal, tessellations

LIT: more complicated quatrines (i.e. Shakespeare), literary vanguards and breaking of symmetries

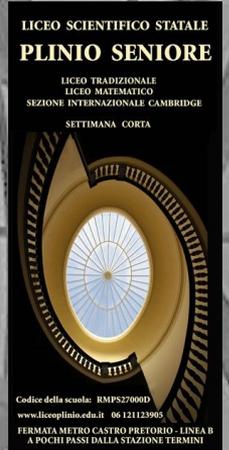
Greetings and contacts

Thank you for your attention.

I hope that you found something interesting for your activities.

Thanks to EASE for having me in this summit. And best regards

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INGEGNO