

# Creativity and Storytelling in Mathematics Education

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Mathigon.org



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$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



SINE RULE

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

COSINE RULE

$$a^2 = b^2 + c^2 - 2bc \cos A$$

OR  $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

$$x^a \times x^b = x^{a+b}$$

$$(x^a)^b = x^{a \times b} = x^{ab}$$

$$x^a \div x^b = x^{a-b}$$

$$\frac{d}{dx}(\sinh(x)) = \cosh(x) \frac{dx}{dx}$$

$$\frac{d}{dx}(\cosh(x)) = \sinh(x) \frac{dx}{dx}$$

$$\frac{d}{dx}(\tanh(x)) = \operatorname{sech}^2(x) \frac{dx}{dx}$$

$$\frac{d}{dx}(\coth(x)) = -\operatorname{csch}^2(x) \frac{dx}{dx}$$

$$\frac{d}{dx}(\operatorname{sech}(x)) = -\operatorname{sech}(x) \tanh(x) \frac{dx}{dx}$$

$$\frac{d}{dx}(\operatorname{csch}(x)) = -\operatorname{csch}(x) \coth(x) \frac{dx}{dx}$$

$$\frac{d}{dx}(\sinh^{-1}(x)) = \frac{1}{\sqrt{x^2 + 1}} \frac{dx}{dx}$$

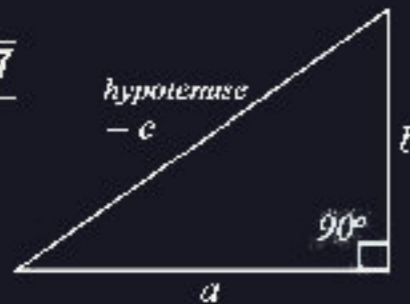
# What is Mathematics all about?

$$\frac{12}{\sqrt{15} - \sqrt{7}} = \frac{12}{\sqrt{15} - \sqrt{7}} \cdot \frac{\sqrt{15} + \sqrt{7}}{\sqrt{15} + \sqrt{7}}$$

$$= \frac{12\sqrt{15} + 12\sqrt{7}}{15 - 7}$$

$$= \frac{12\sqrt{15} + 12\sqrt{7}}{8}$$

$$= \frac{3\sqrt{15} + 3\sqrt{7}}{2}$$



$$c^2 = a^2 + b^2$$



$$a + b + c = 180^\circ$$



$$a + b + c = 180^\circ$$



$$a + b + c + d = 360^\circ$$



sine

$$\sin = \frac{o}{h}$$



cosine

$$\cos = \frac{a}{h}$$



tangent

$$\tan = \frac{o}{a}$$

$A \cup B$ : "A union B" i.e. A or B or both

$A \cap B$ : "A intersection B" i.e. both A and B



# What is Mathematics all about?

## Meaningful Mathematics

*Art and Beauty*

*History of  
Mathematics*

*Puzzles, Patterns  
and Games*

*Understanding  
Nature and Science*

*Fiction*

## Useful Mathematics

*Problem-solving*

*Critical Thinking*

*Creativity*

*Abstraction*

*Precision*

## Applications

*Arithmetic + Algebra*

*Modelling + Simulation*

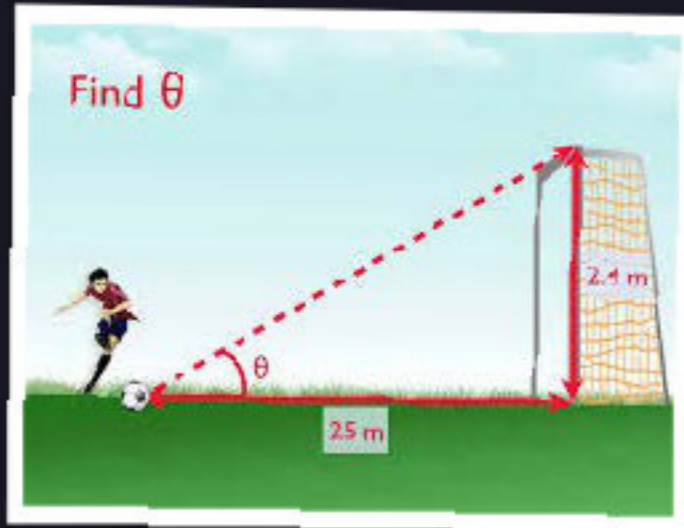
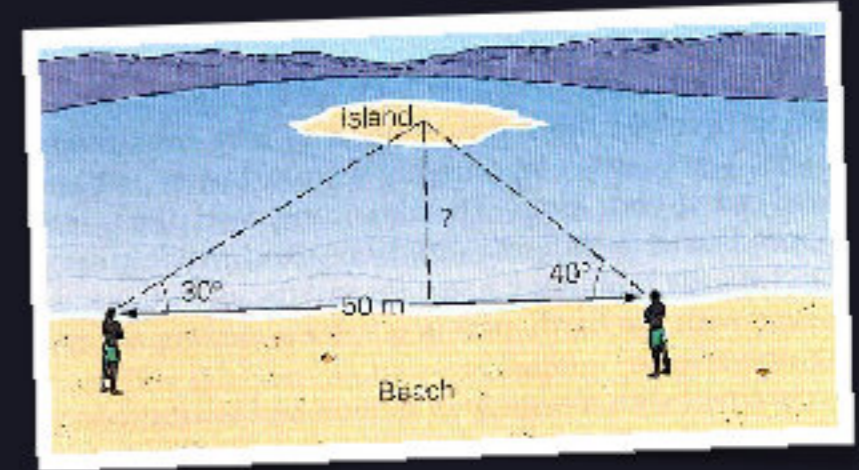
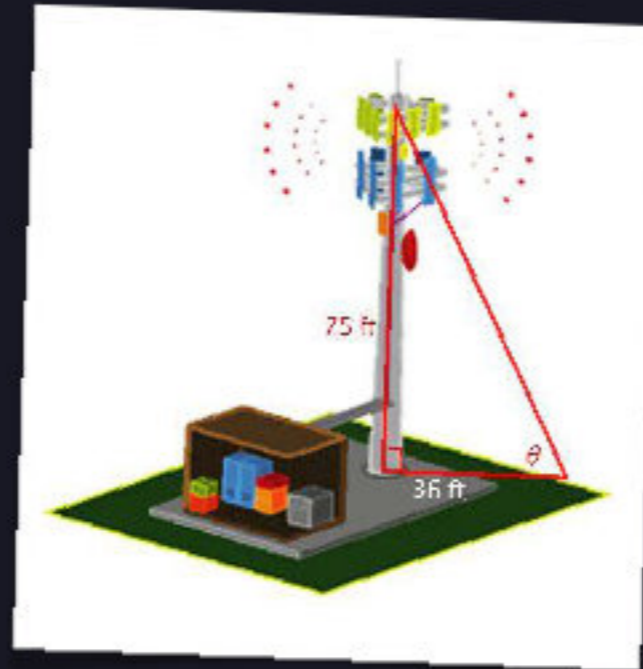
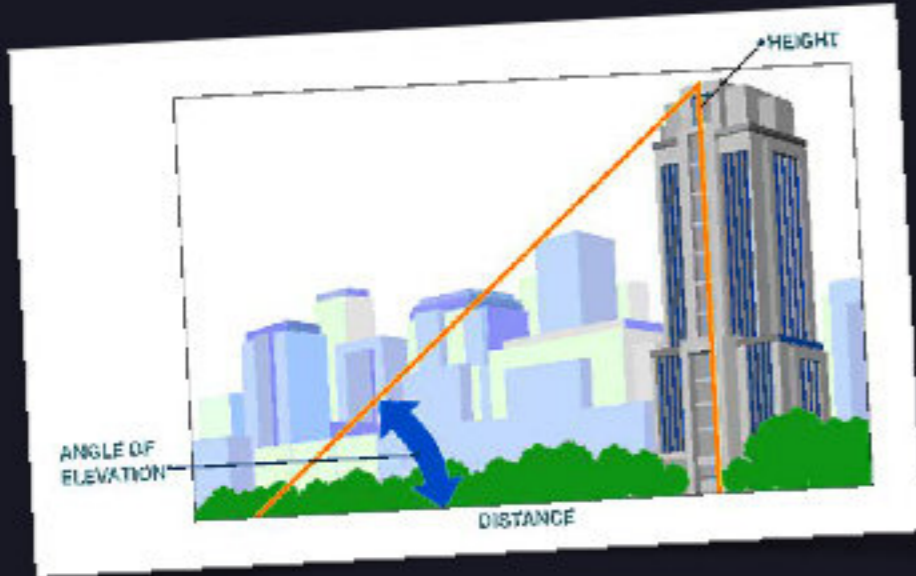
*Data Science*

*Cryptography*

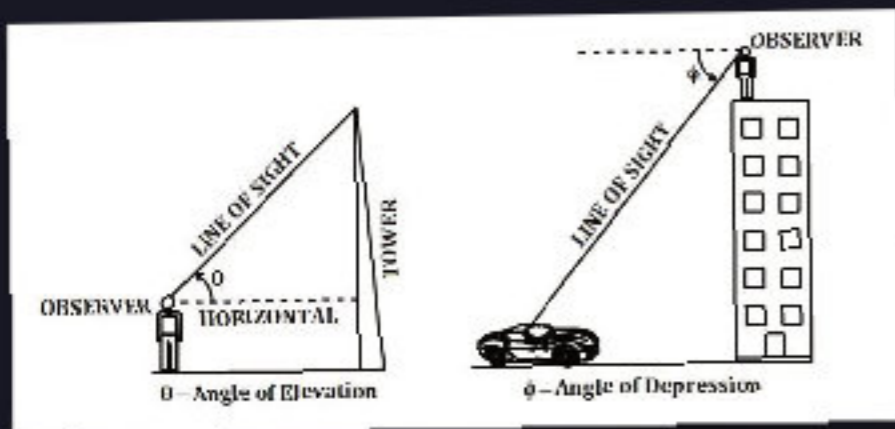
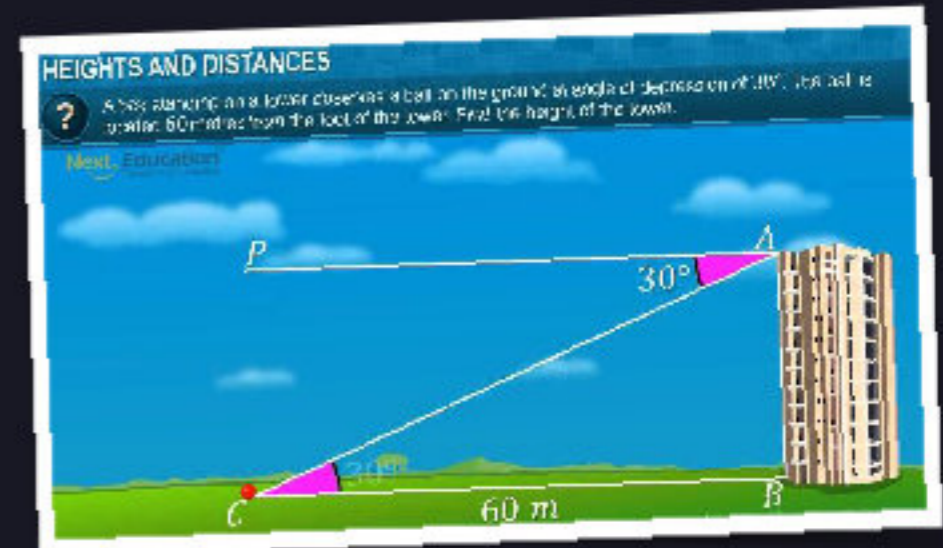
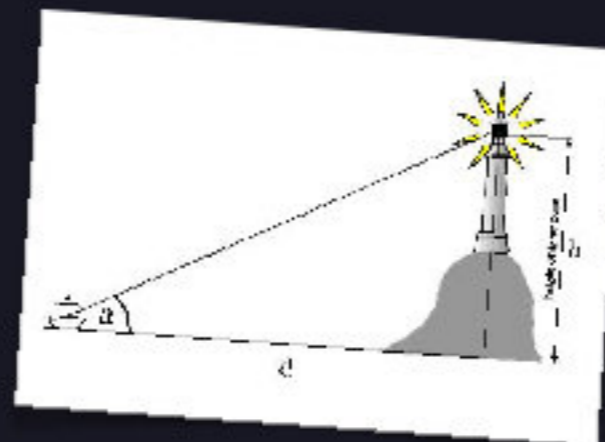
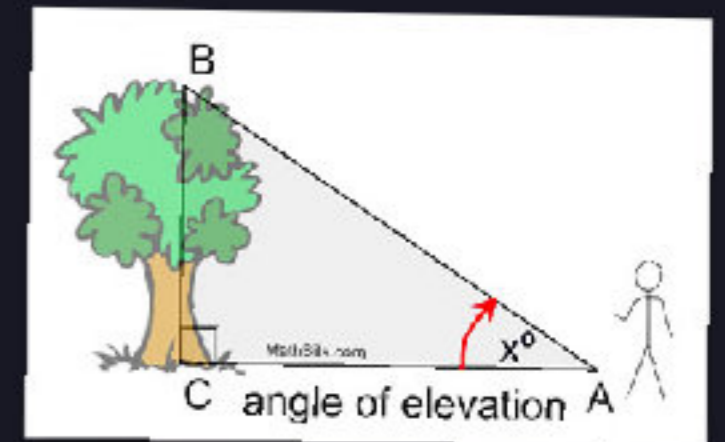


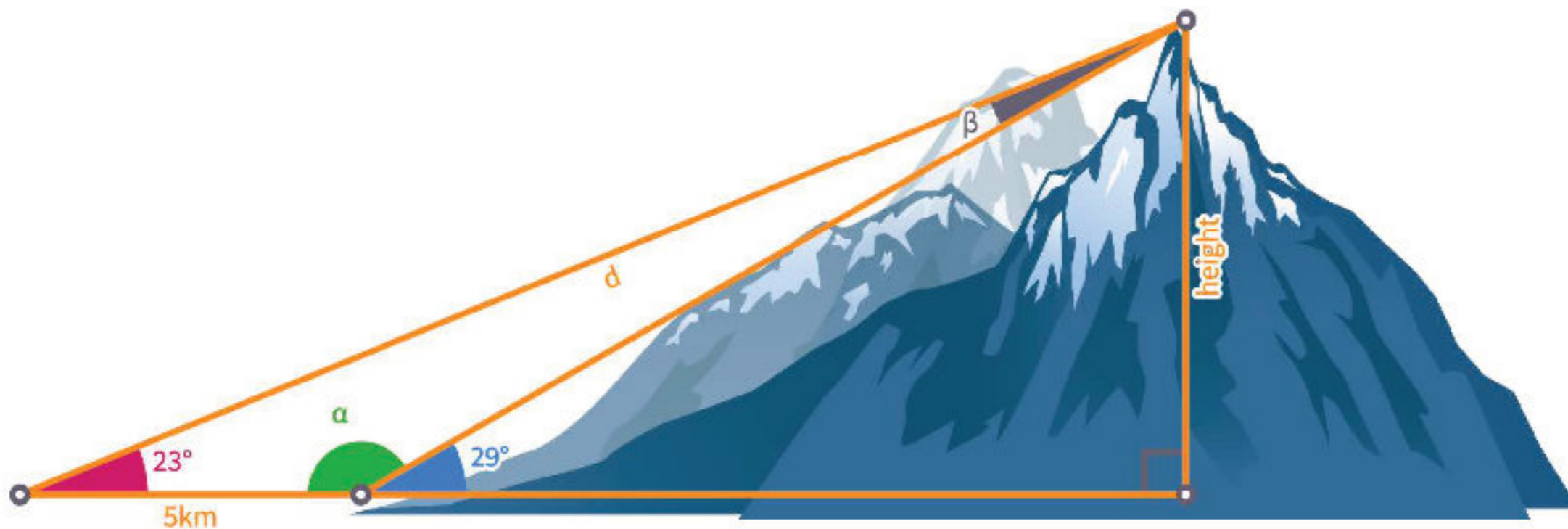
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# Storytelling



# Trigonometry





$$\frac{\sin 151^\circ}{d} = \frac{\sin 6^\circ}{5}$$

# Trigonometry





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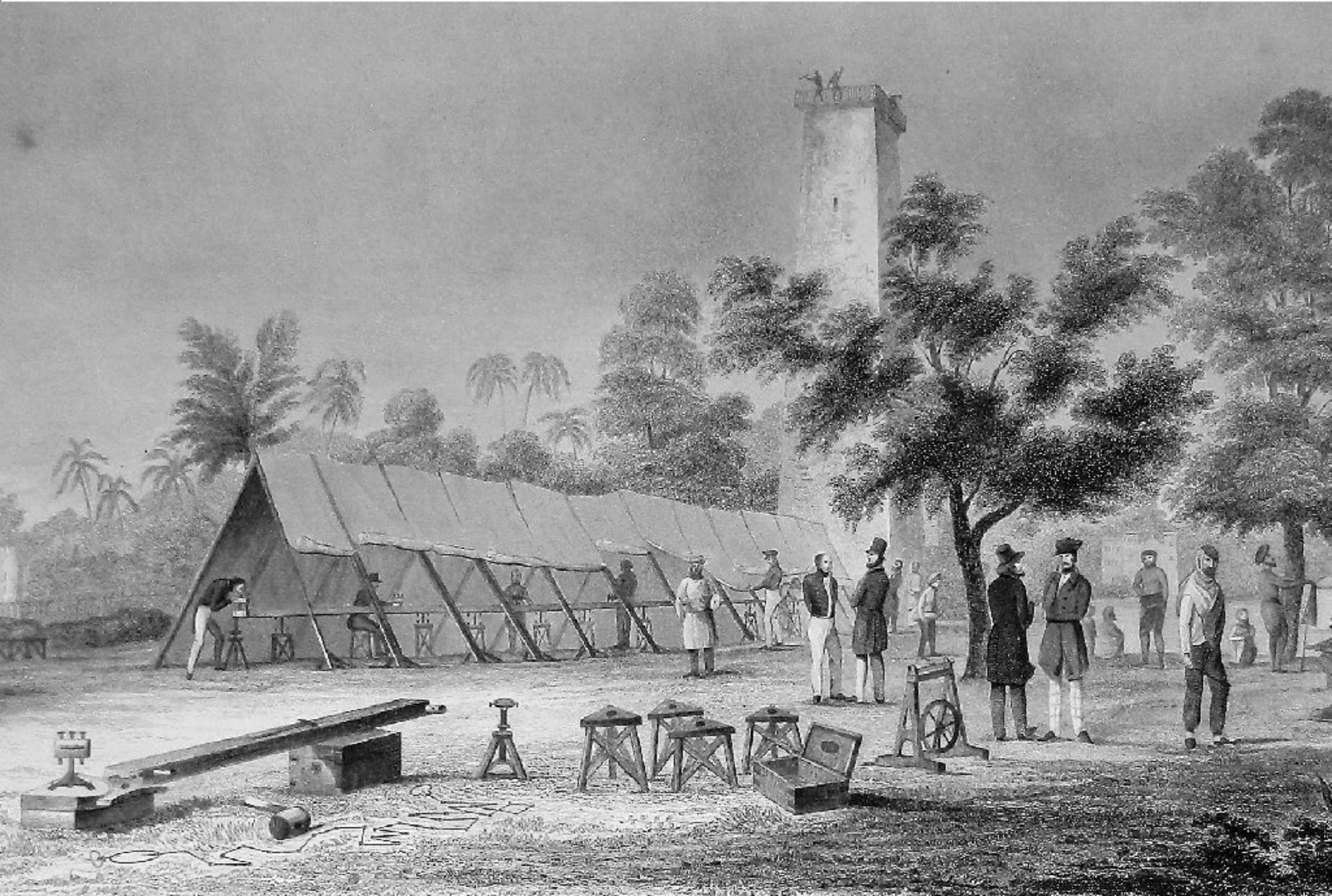


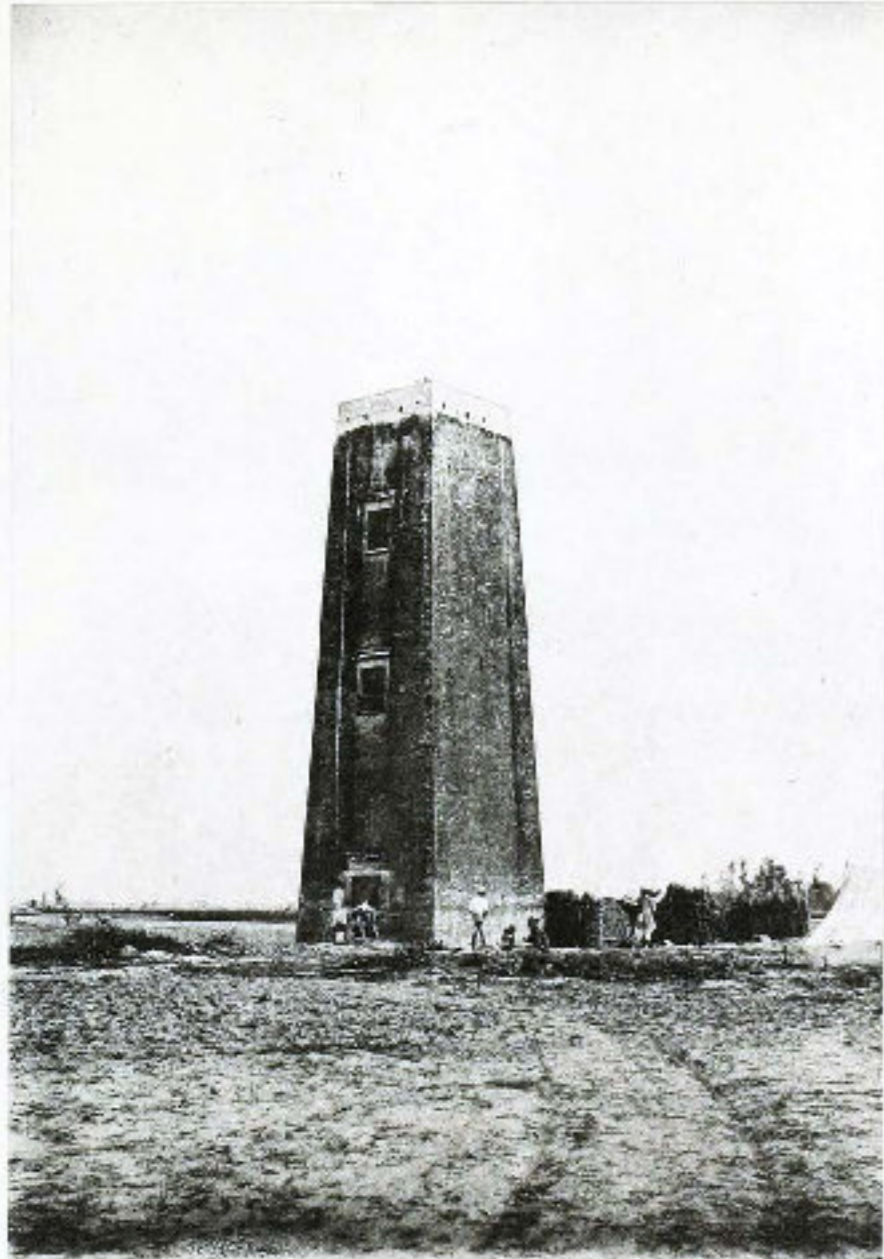
# Mount Everest



INDEX CHART  
TO THE  
GREAT TRIANGONOMETRICAL SURVEY  
OF  
**INDIA**

INDIAN COUNCIL OF TEACHERS OF MATHEMATICS  
THE UNIVERSITY OF DELHI  
THE GOVERNMENT OF INDIA  
THE SURVEY OF INDIA  
THE SURVEY OF INDIA





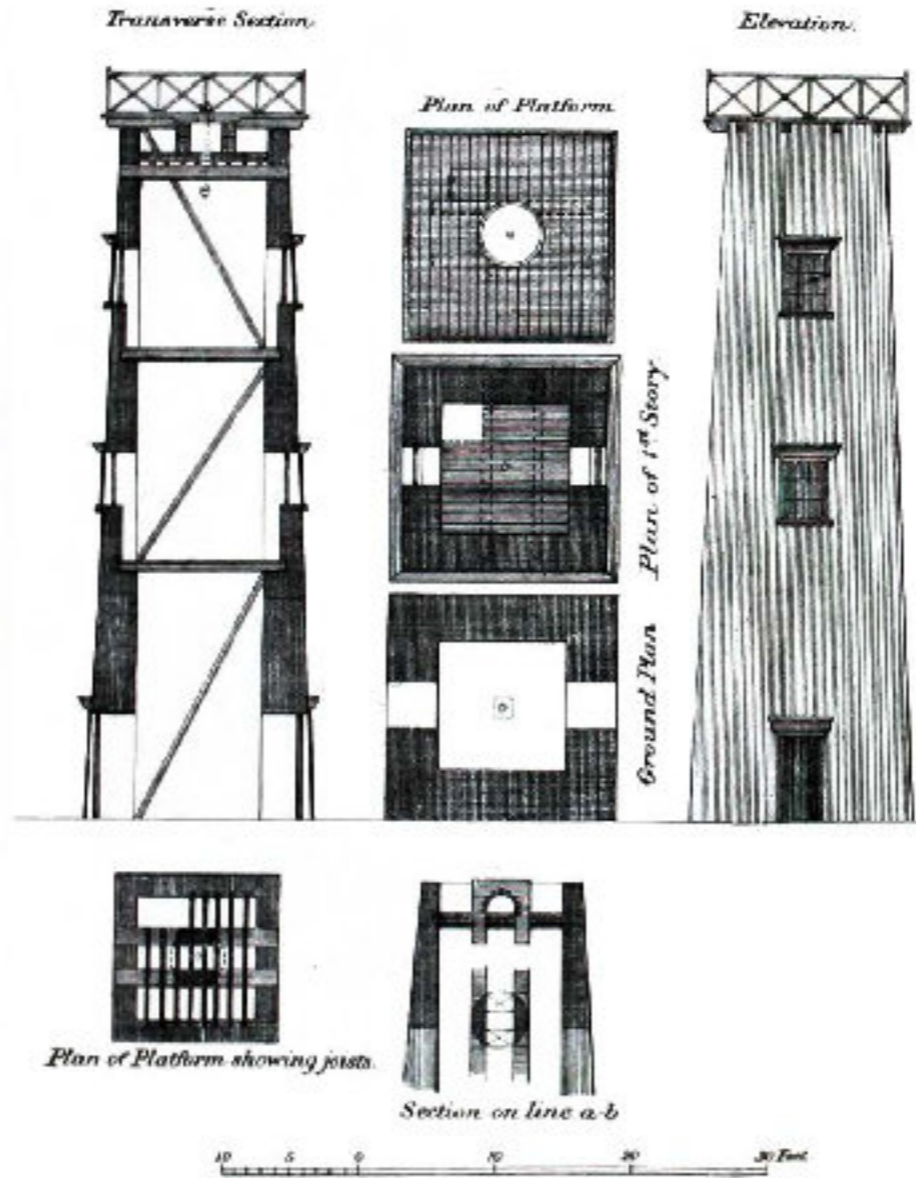
Harvey Jones

Survey of India Office Calcutta December 1844

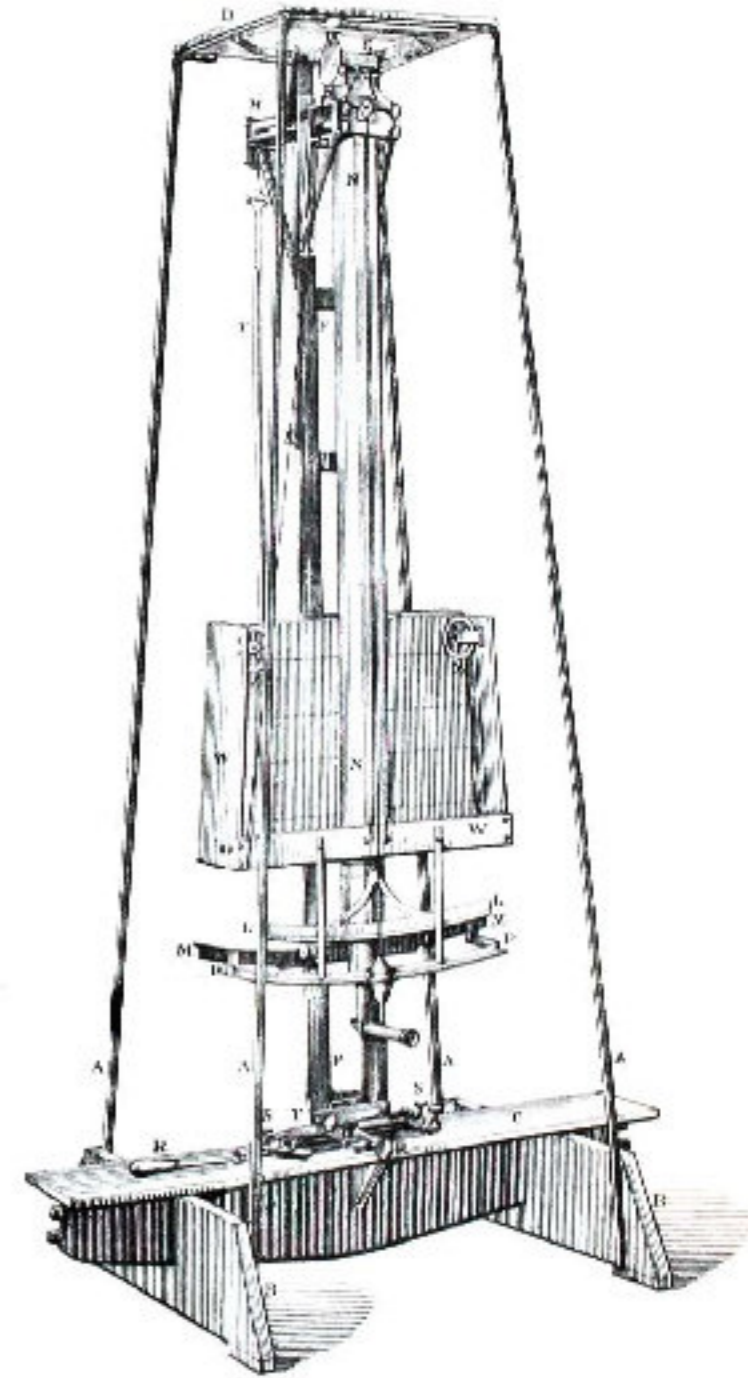
**NOJLI TOWER**

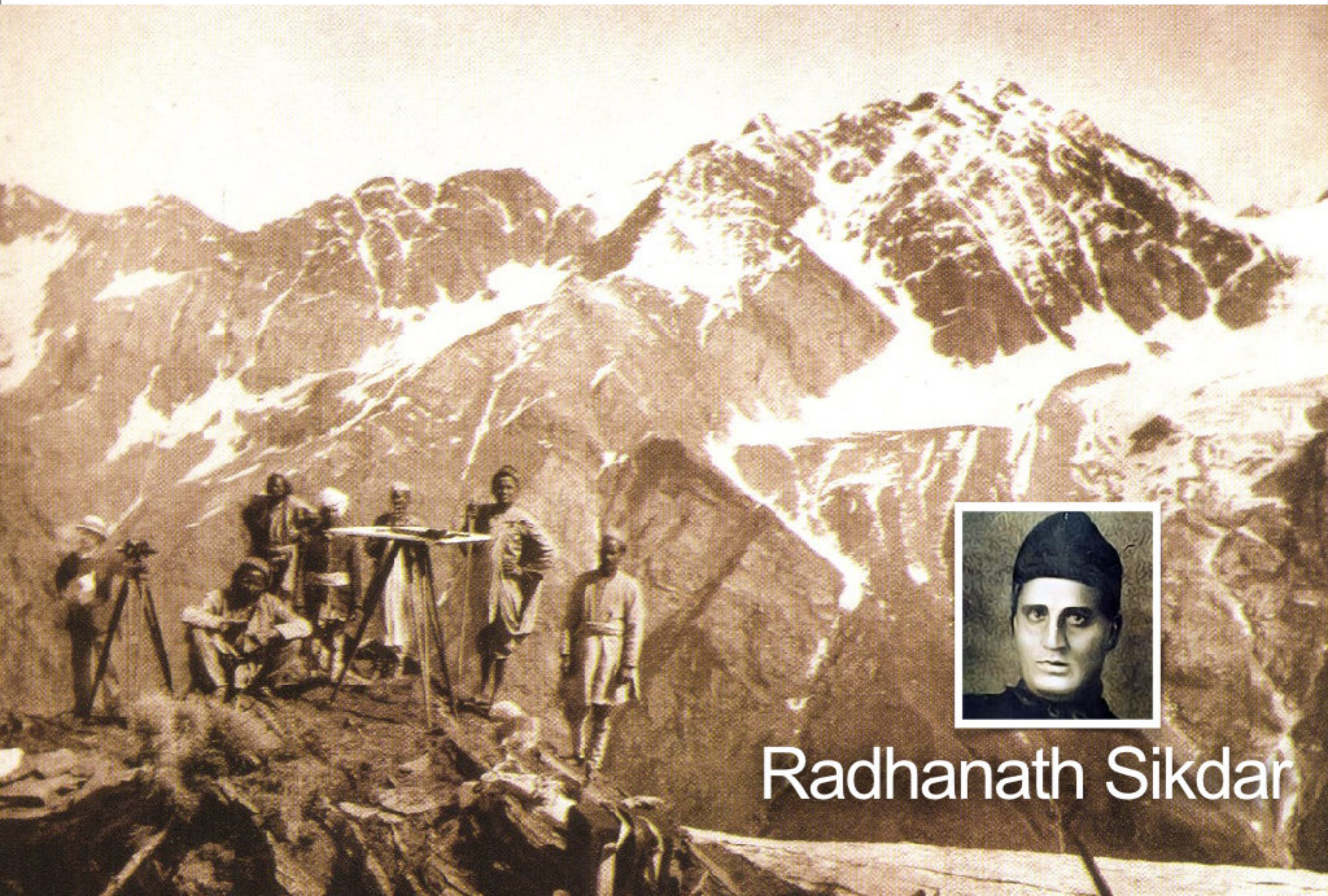
A STATION OF THE GREAT TRIGONOMETRICAL SURVEY BUILT IN THE PLAINS OF UPPER INDIA NEAR NOJLI AND FROM WHICH THE HIMALAYAN PEAKS OF HAMBURGH, SEIKERATHI, JAWLI AND BANDARTUNGK HAVE BEEN OBSERVED  
FROM A PHOTO BY C. L. SIMONS.

**ELEVATION, SECTIONS & PLANS.**  
*Illustrative of Colonel Everest's Towers on the  
Great Arc.*

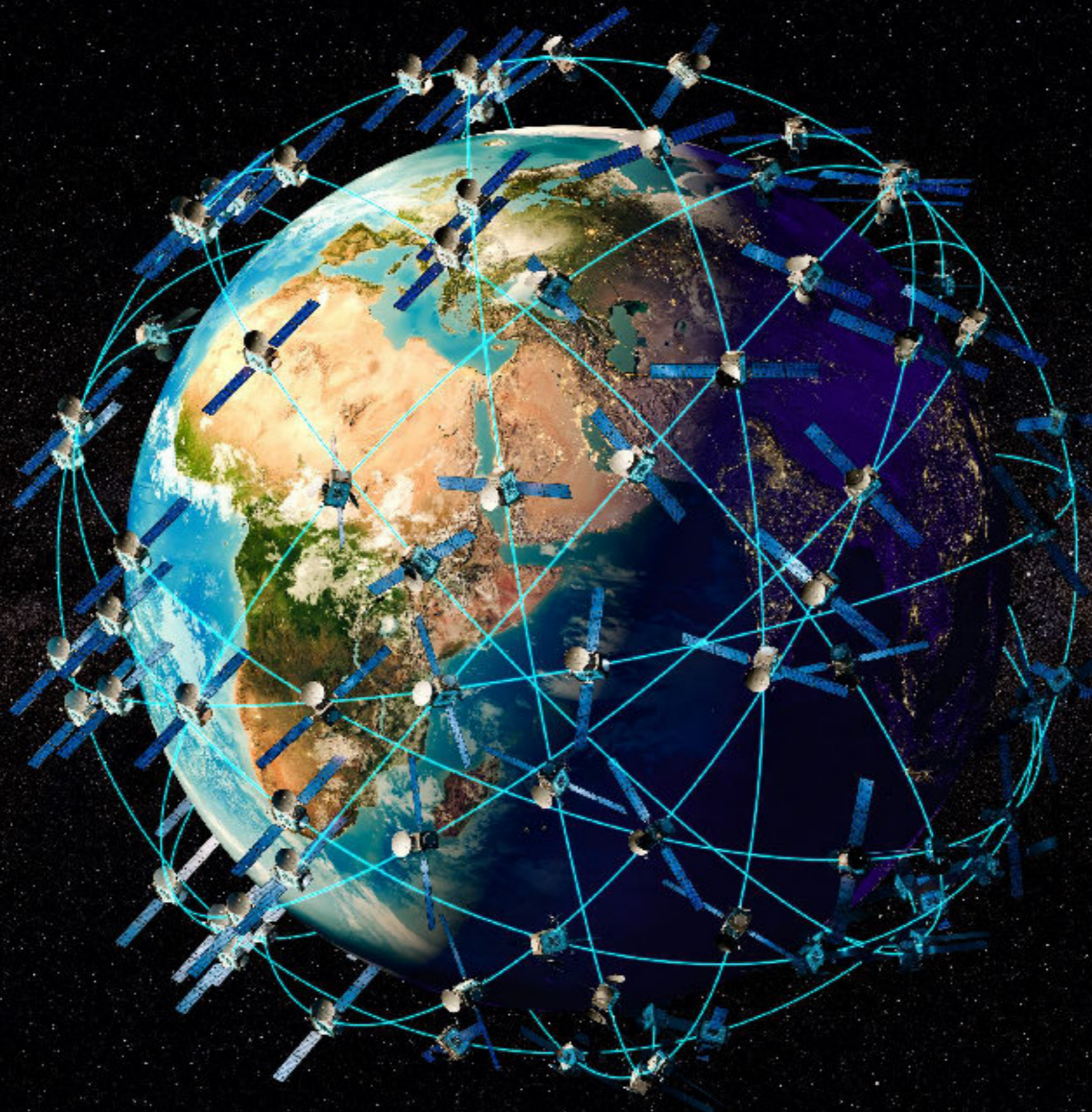


**OLD ZENITH SECTOR, (RAMSDEN'S)**





Radhanath Sikdar



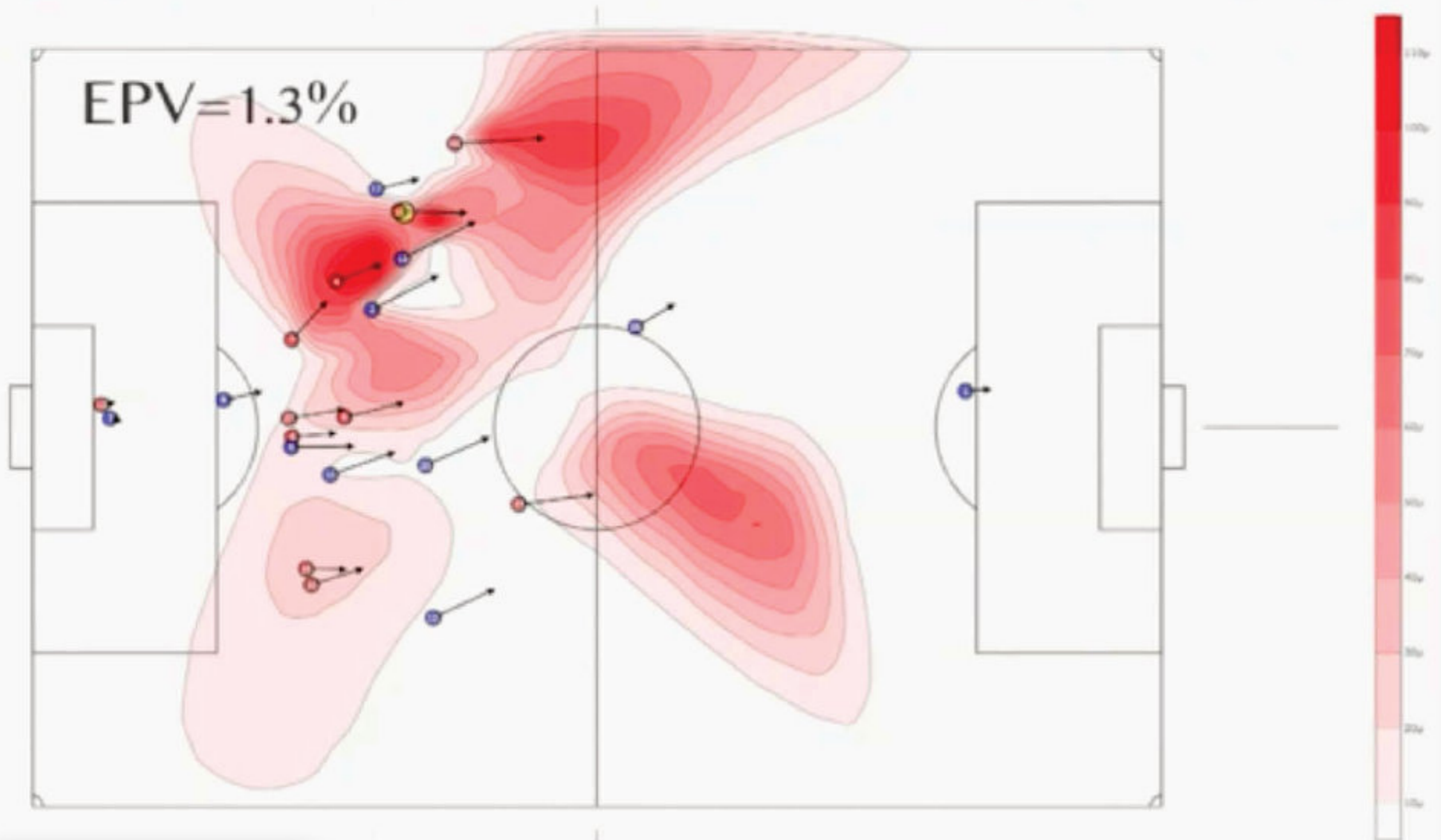
**GPS**

# PLAY-OFF



**Sports Brackets**





**Football**



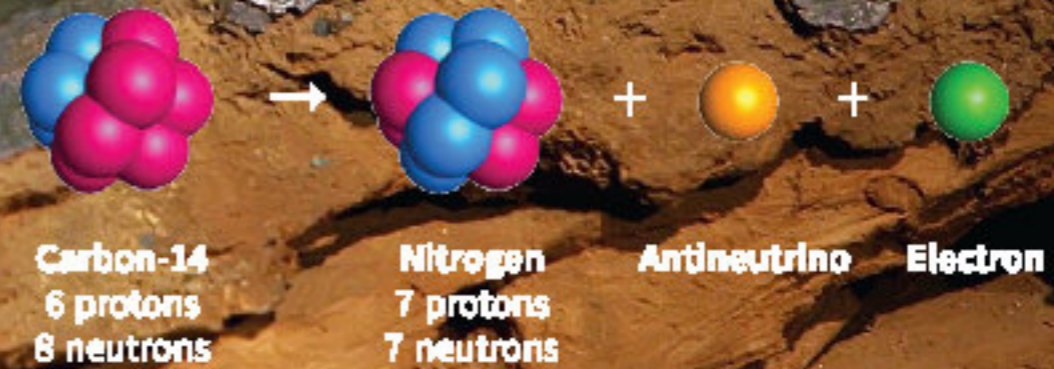
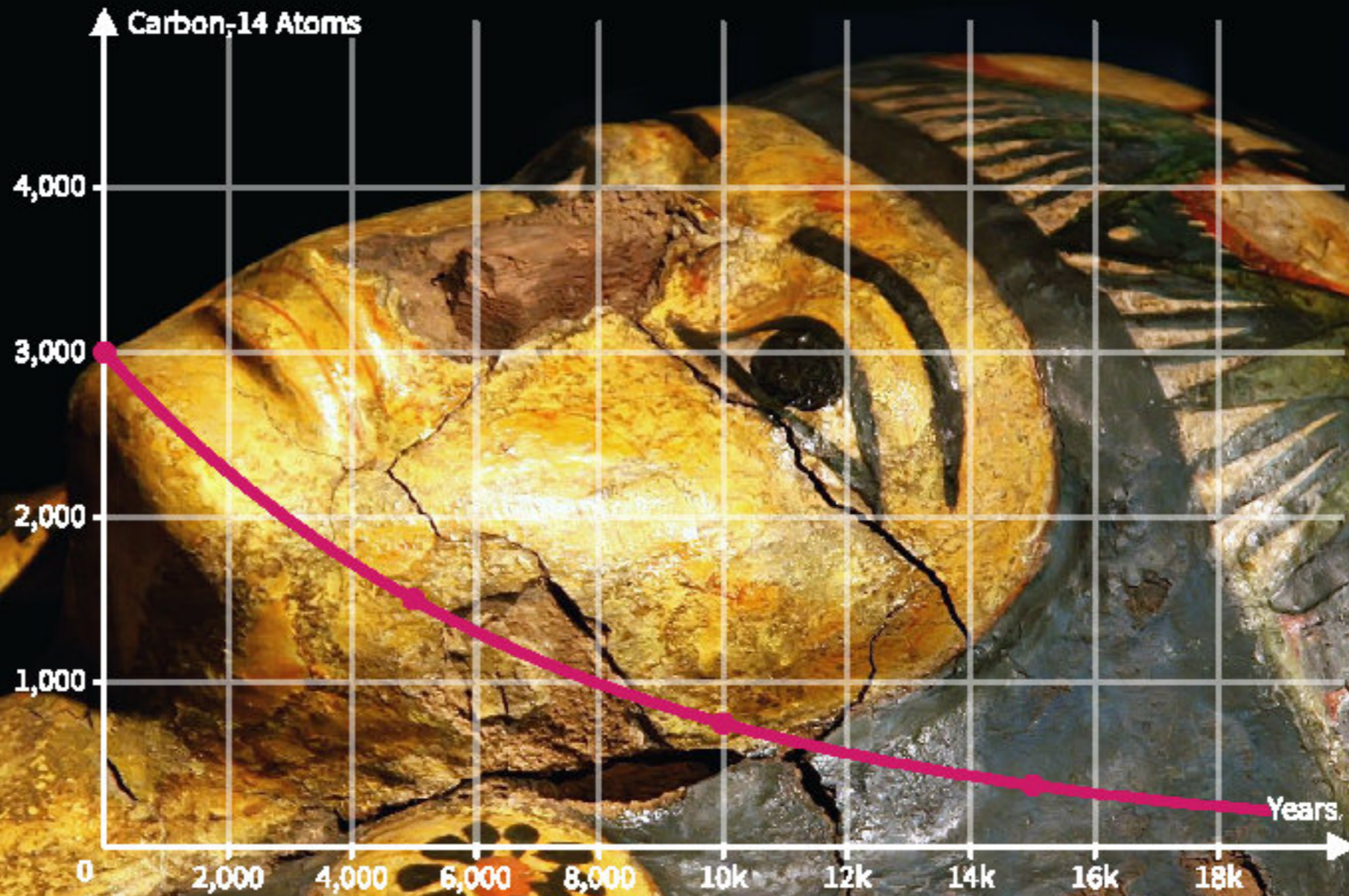


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[mathigon.org/go/carbon](https://mathigon.org/go/carbon)



# Carbon Dating



# Carbon Dating



13

17

**Cicadas**



<https://mathigon.org/>

13, 17



Alice

Public Key  
221



Bob

**Public Key Cryptography**



Position



Velocity



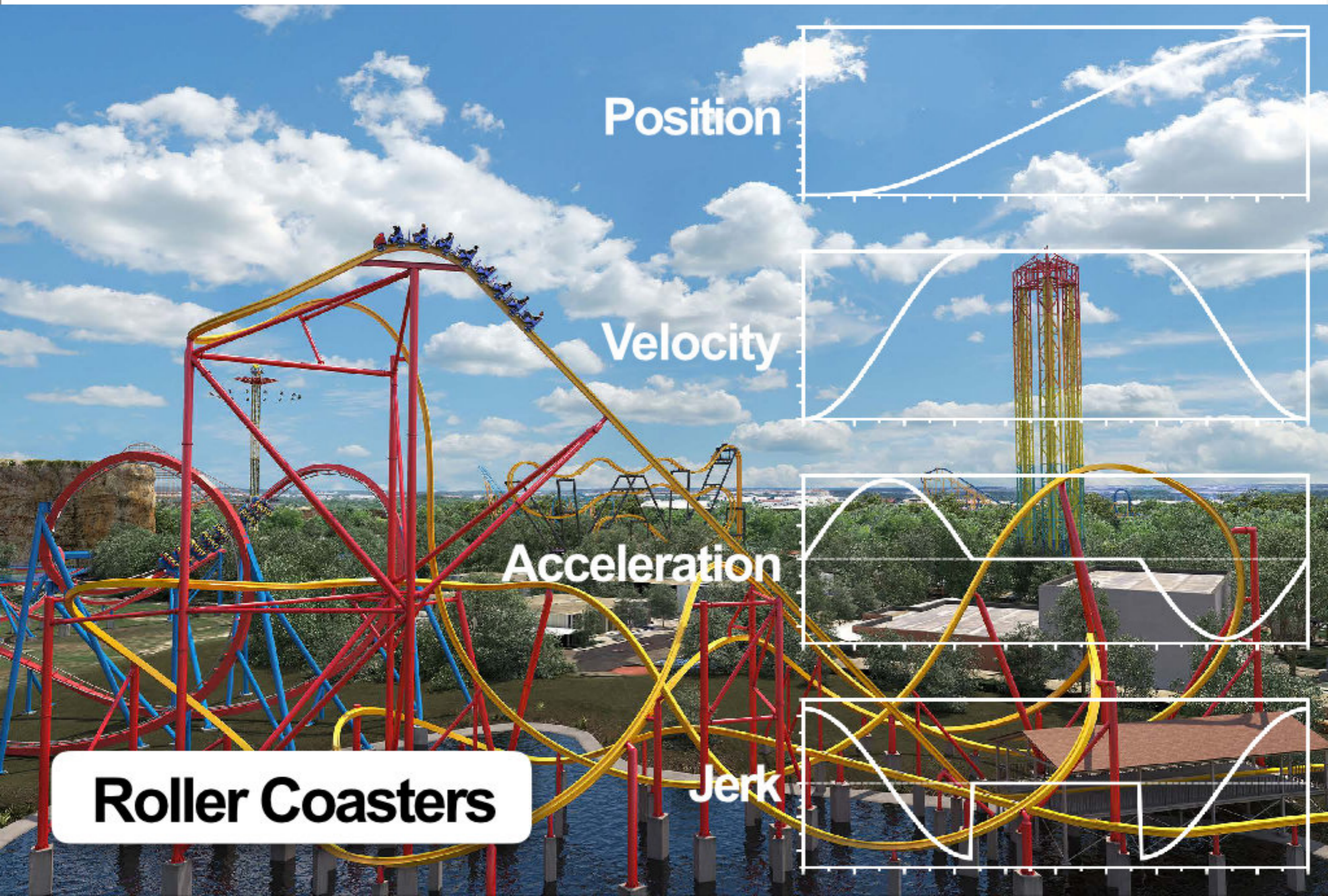
Acceleration

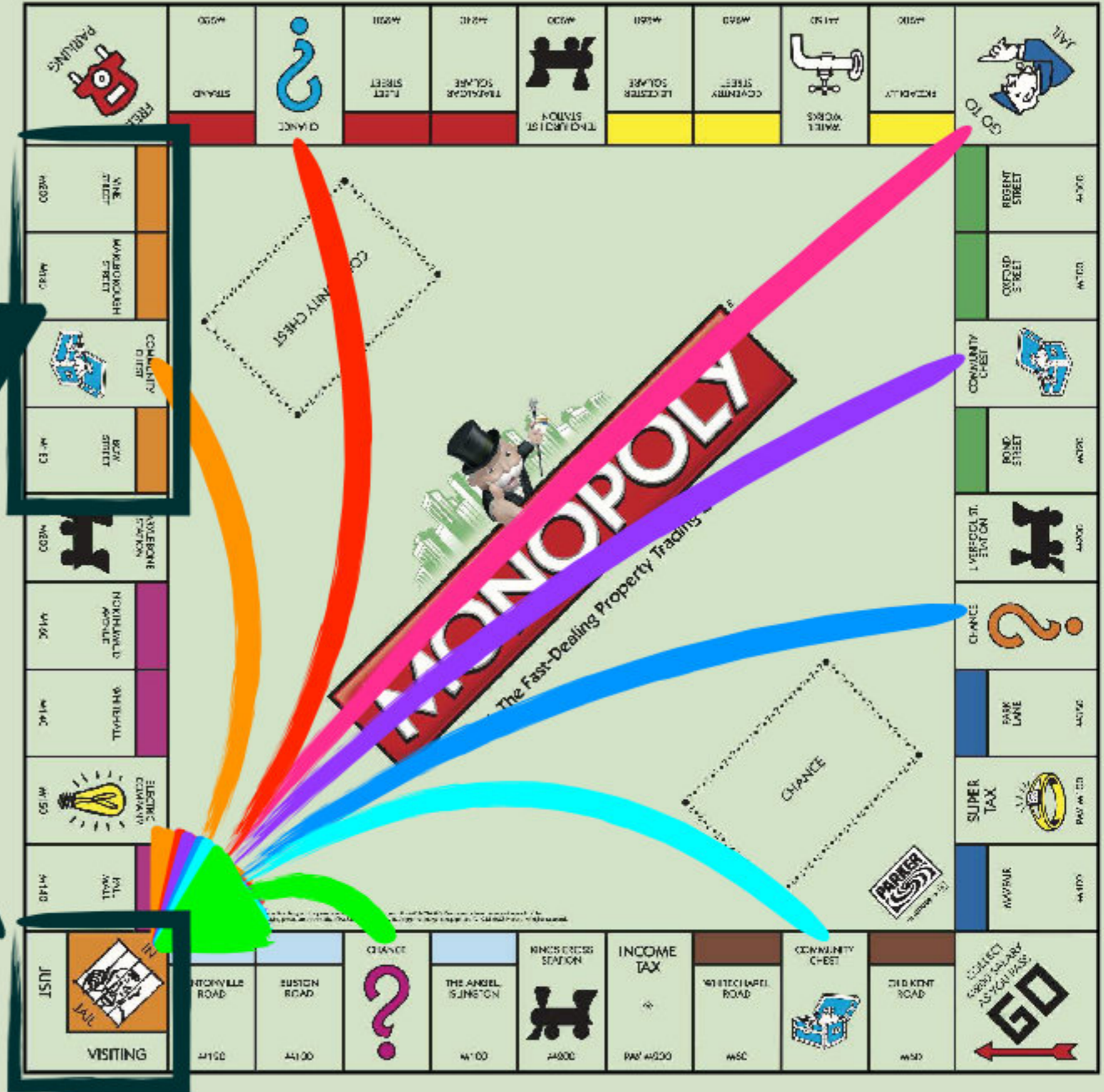
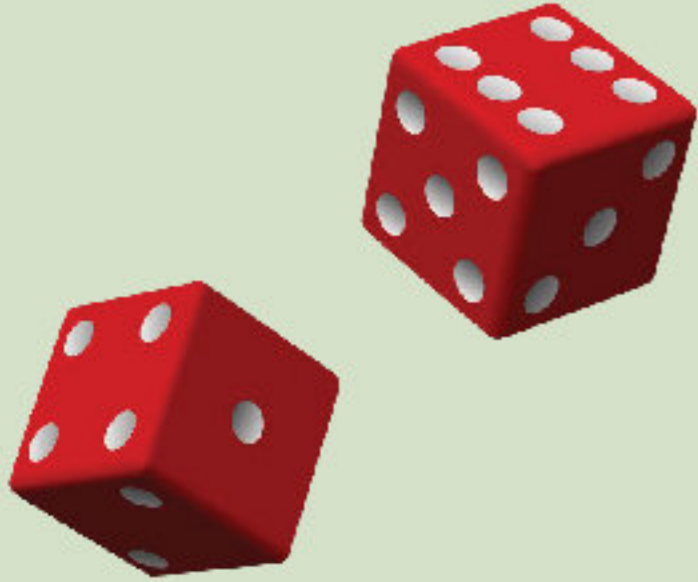


Jerk



# Roller Coasters





# Monopoly



**Monopoly**



**Roulette**





Red Black



RR RB BR BB

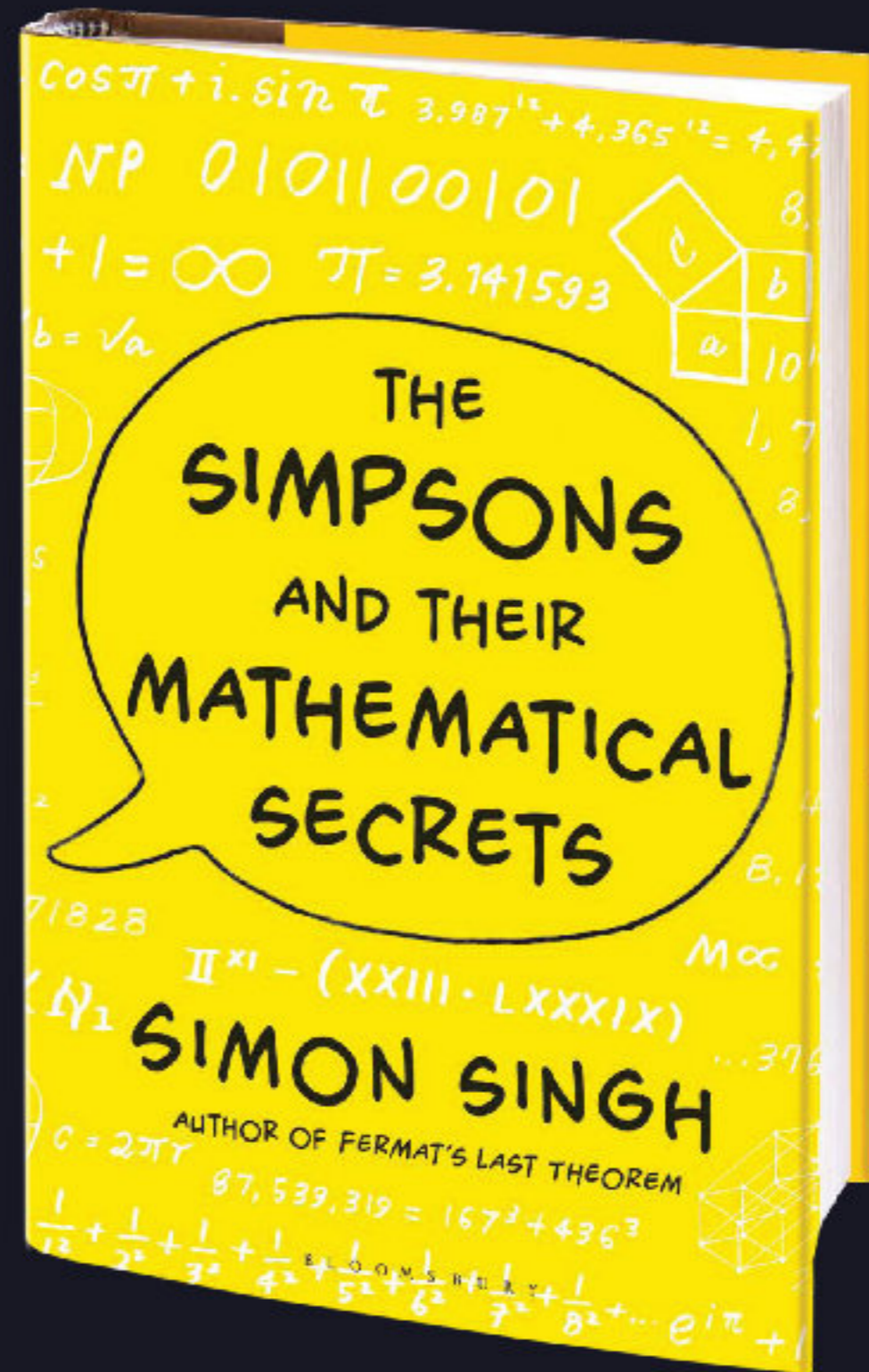


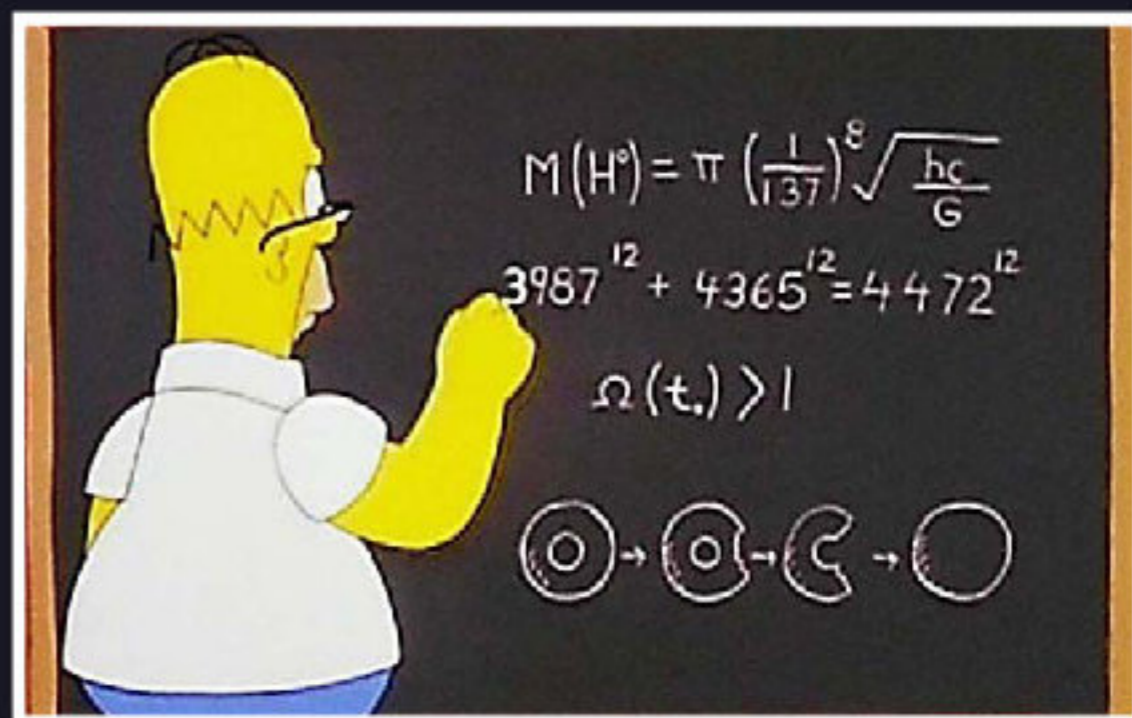
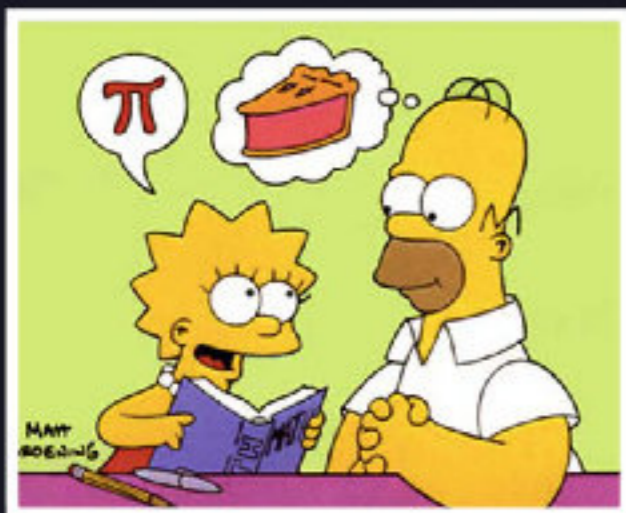
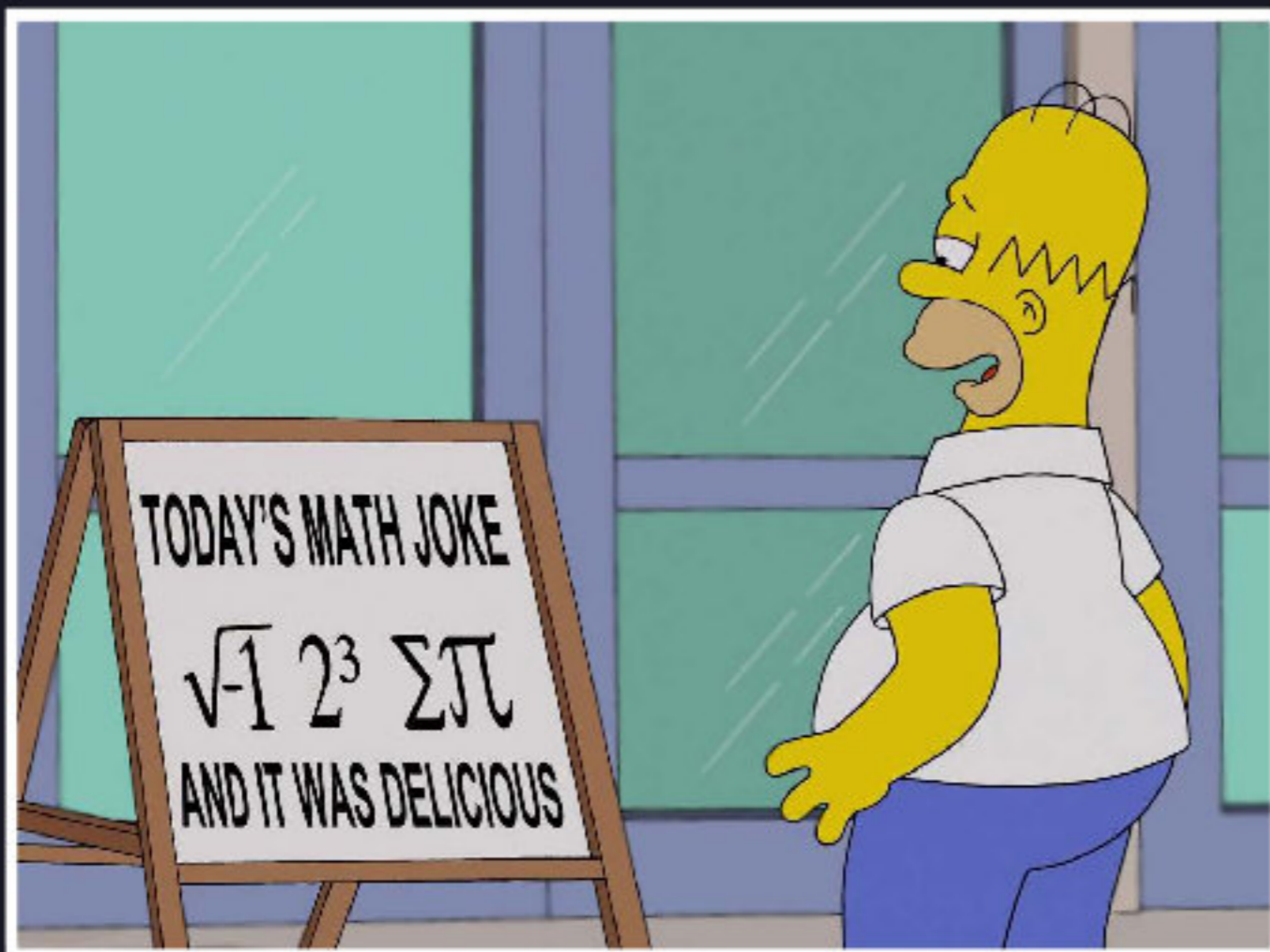
RRR RRB BRR RBR BRB BBR RBB BBB

# Roulette

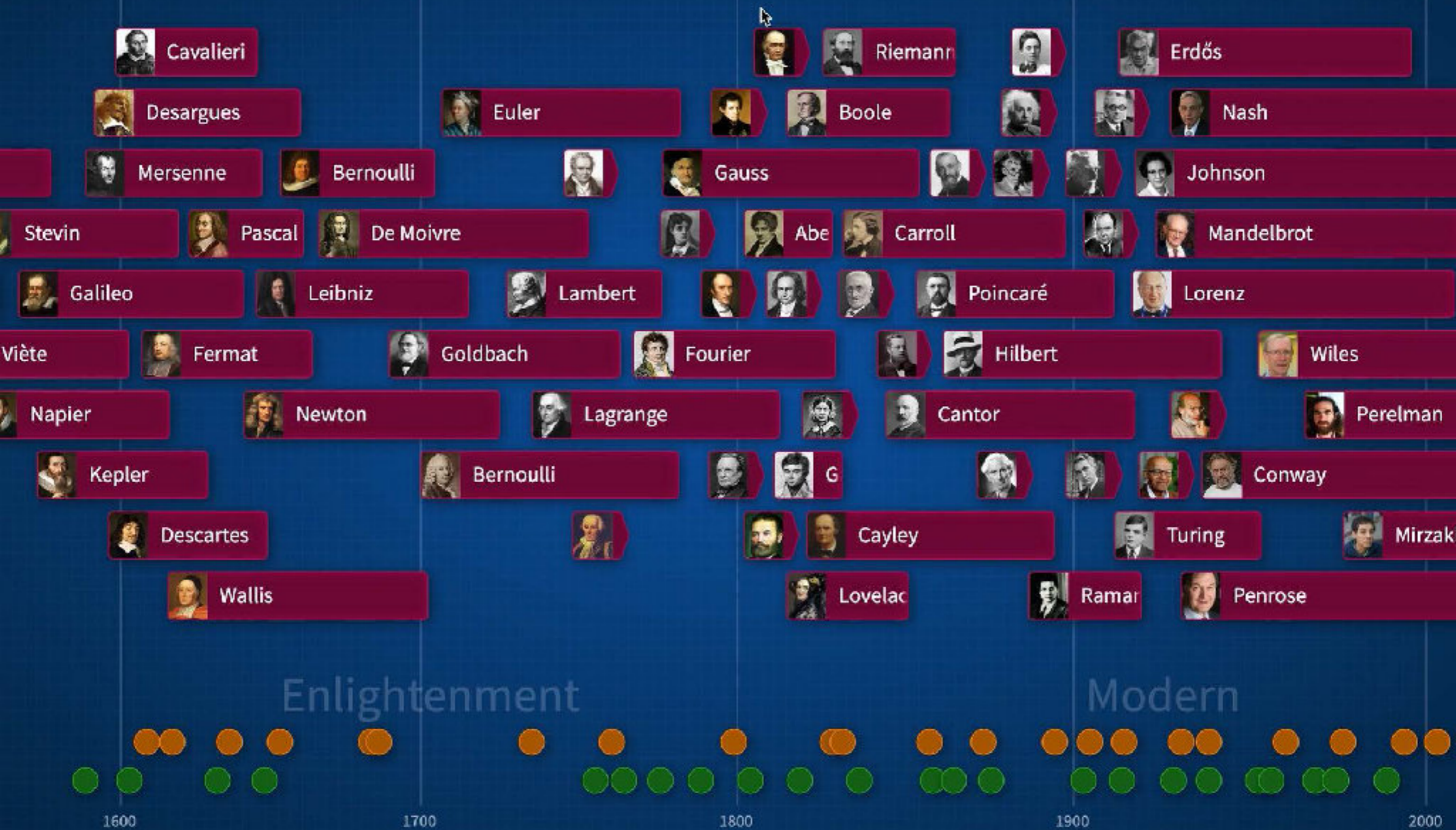


**Lottery**





# Timeline of Mathematics





# Mathematics is filled with Stories!



**Applications**



**Science  
and Nature**



**Games and  
Puzzles**



**History and  
Mathematicians**



**Fiction**



# Stories are great for teaching!

**Get students  
excited and  
motivated**

**Make the  
content more  
memorable**

**Show careers  
and people  
who use math**

**Encourage to  
keep studying  
math and STEM**



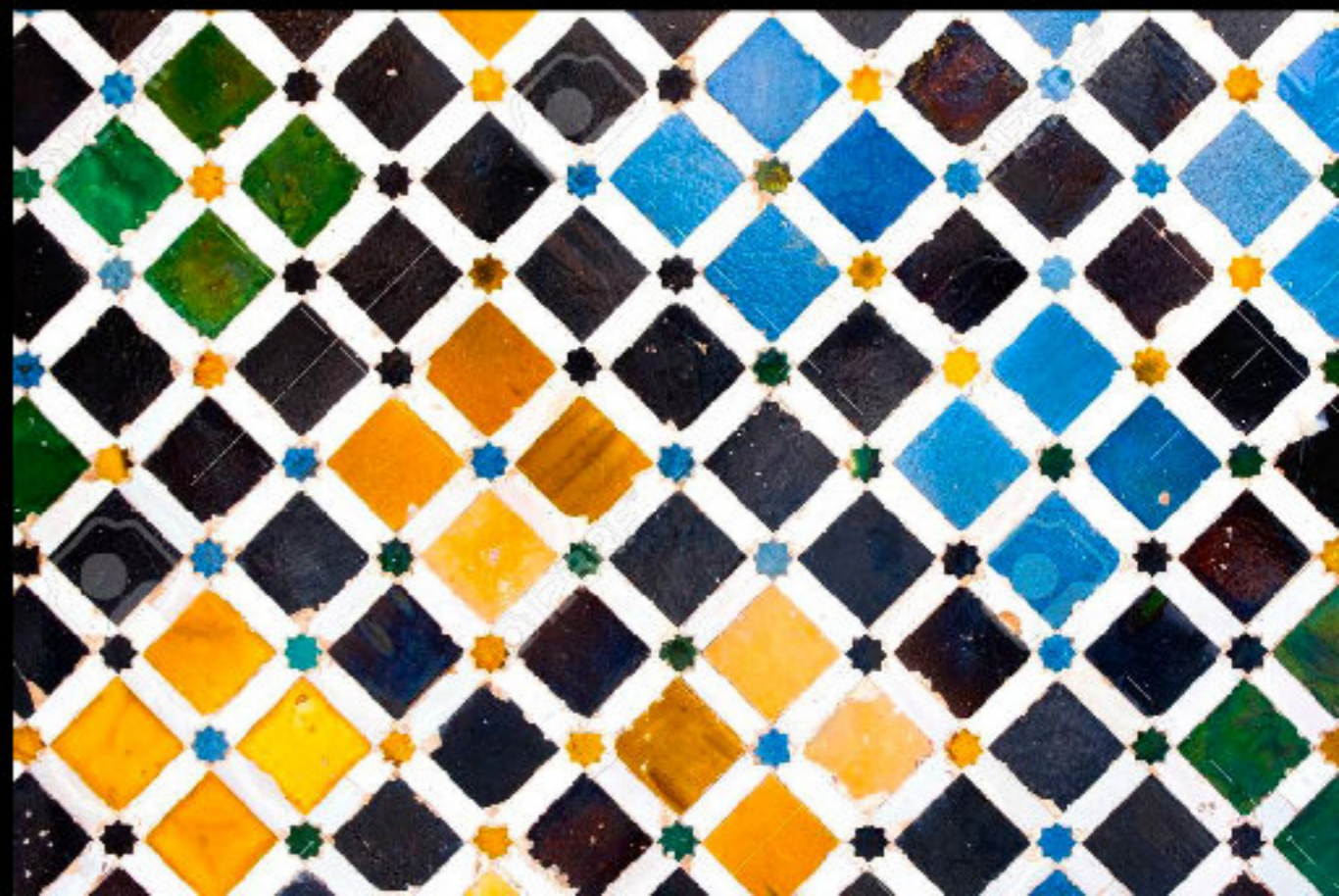
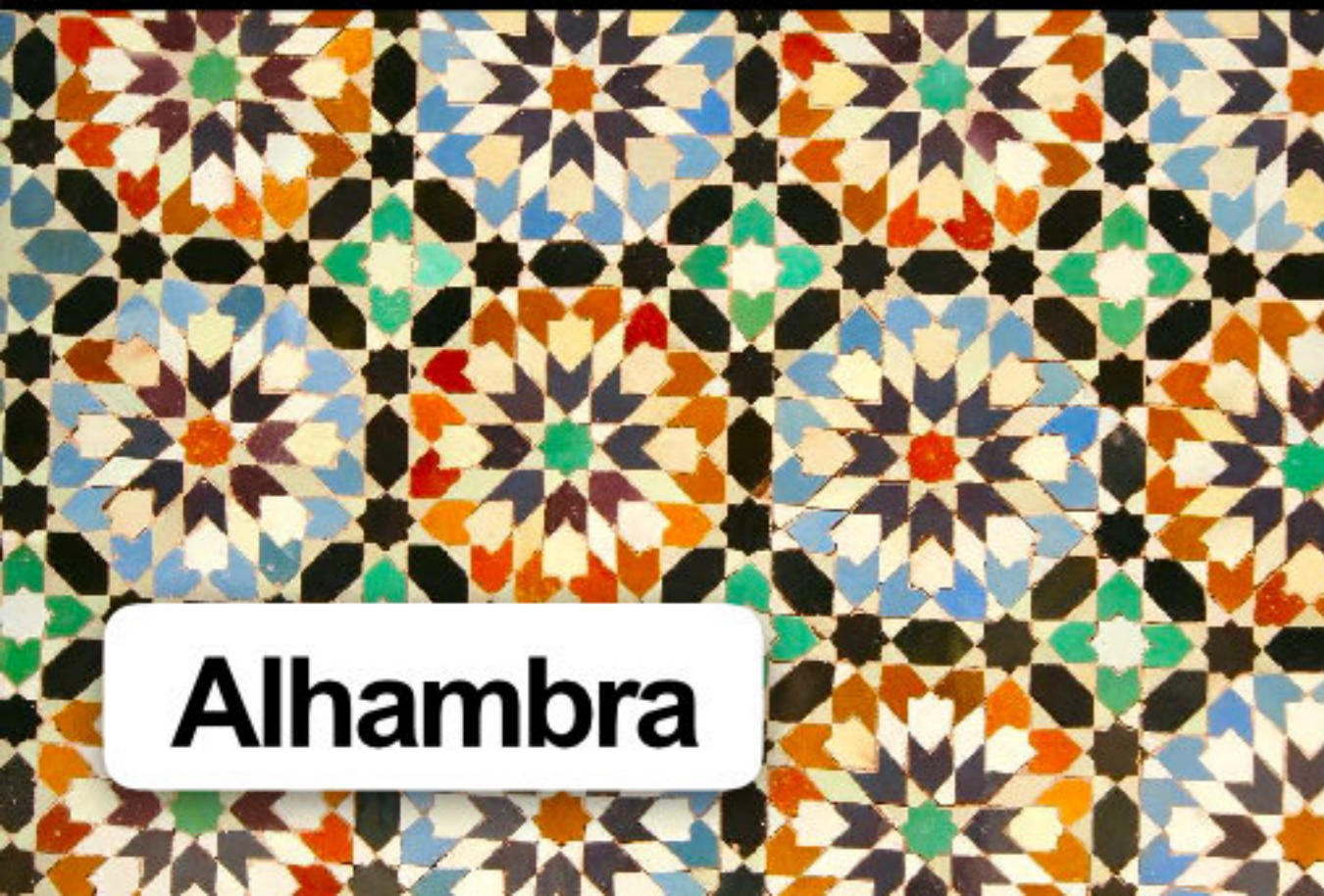
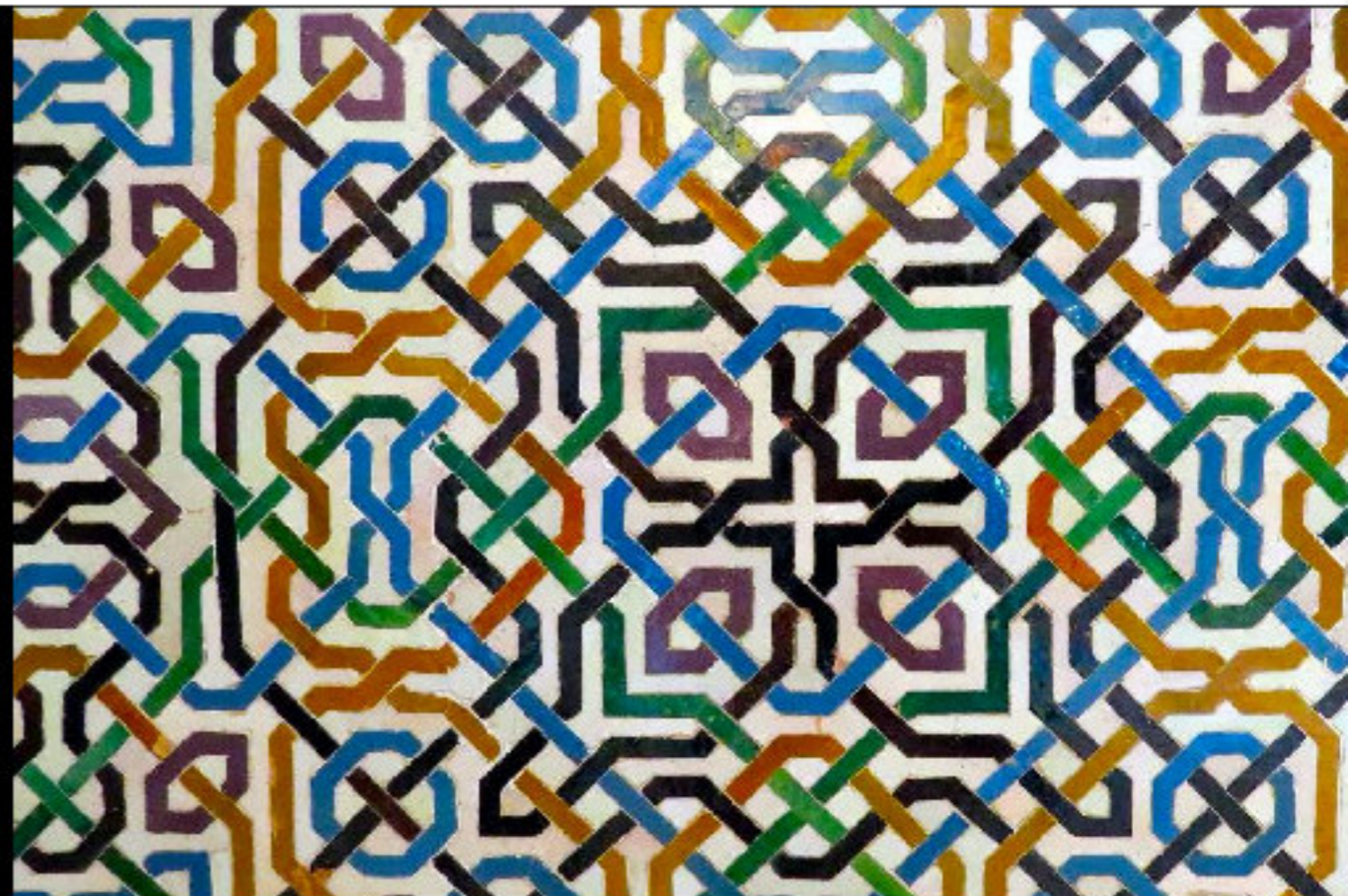
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# Creativity





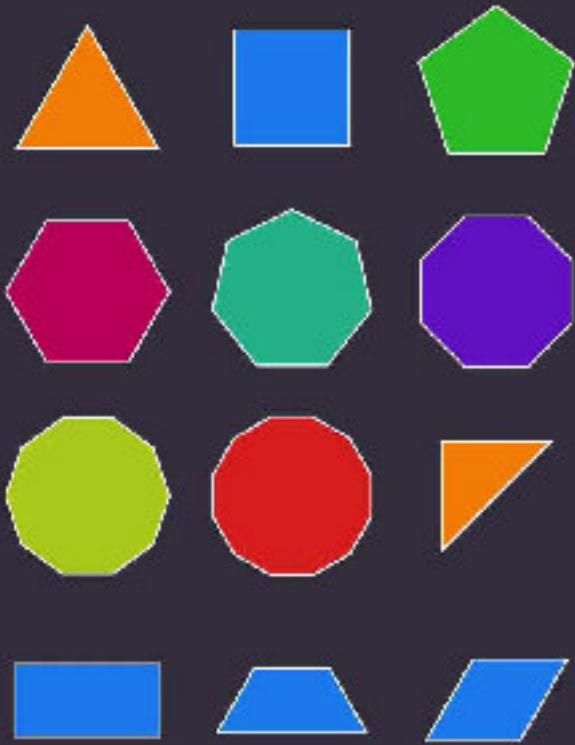
# Tessellations



**Alhambra**



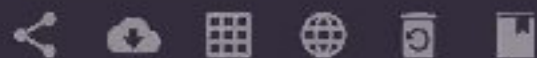
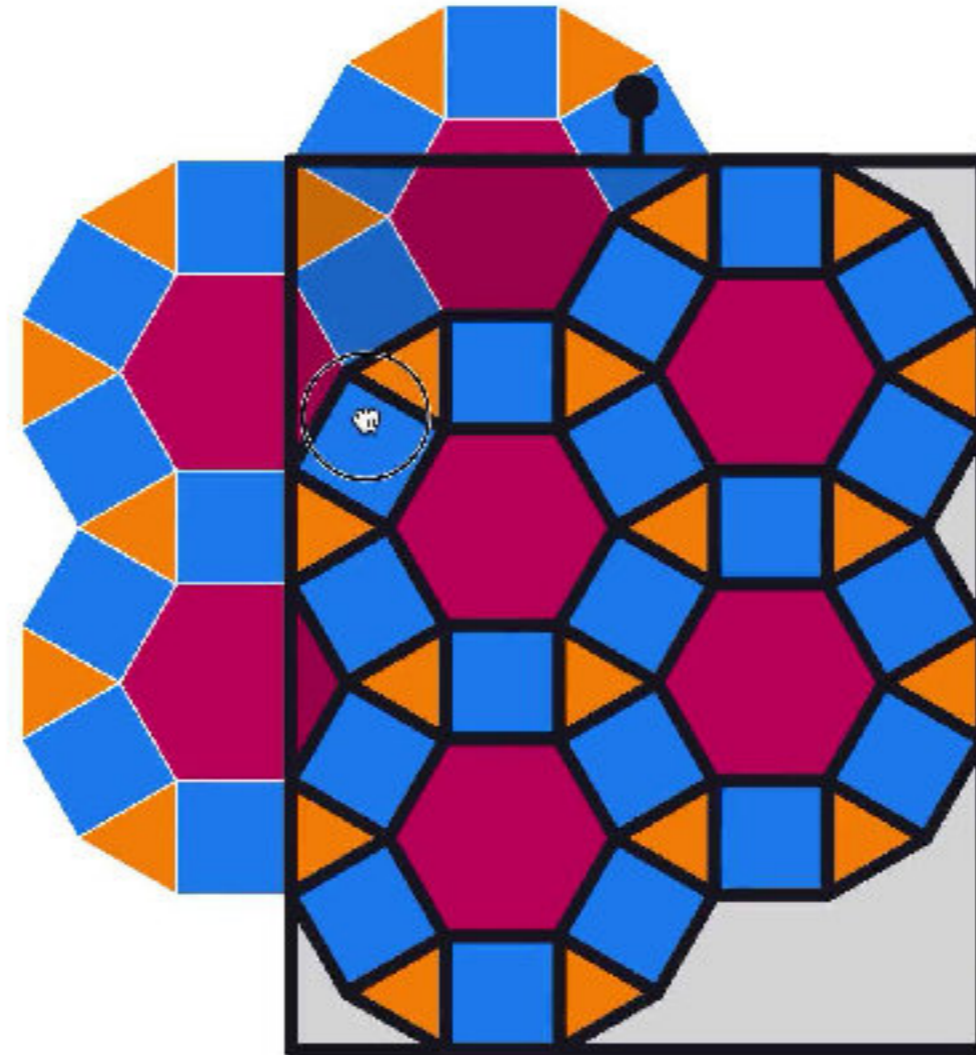
### POLYGONS

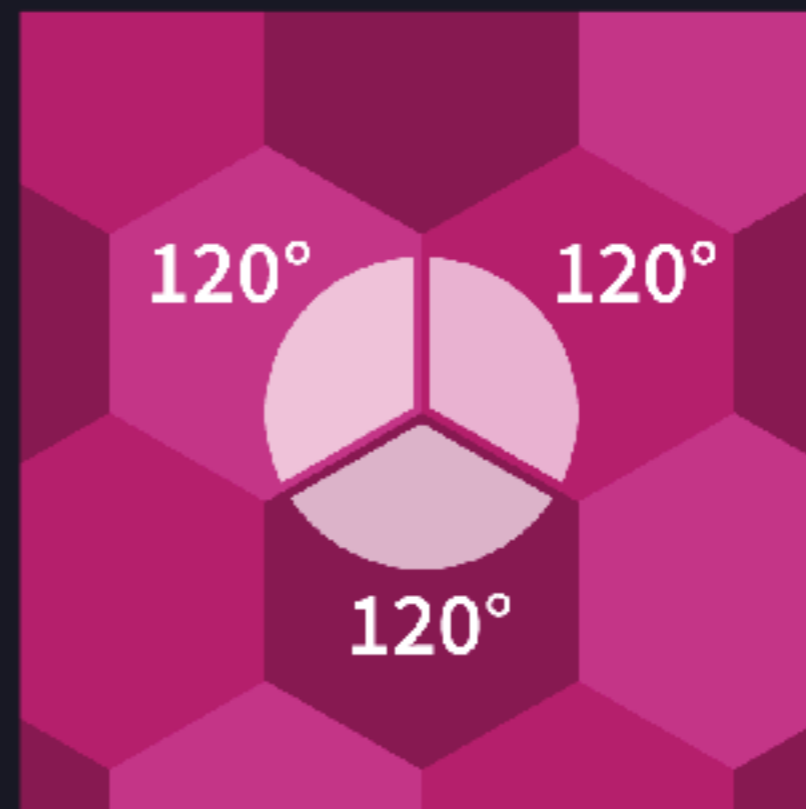
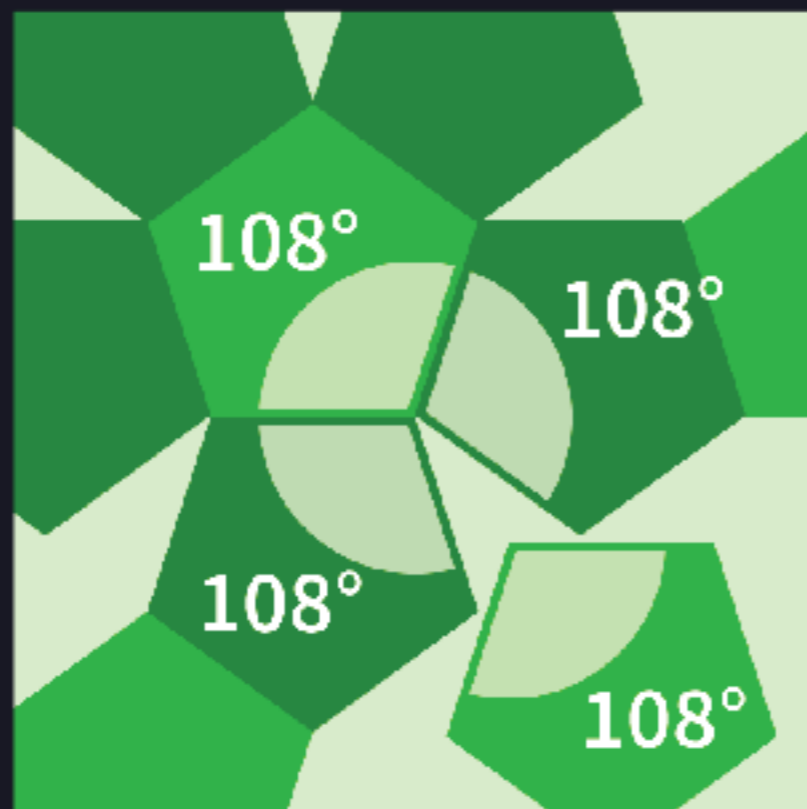
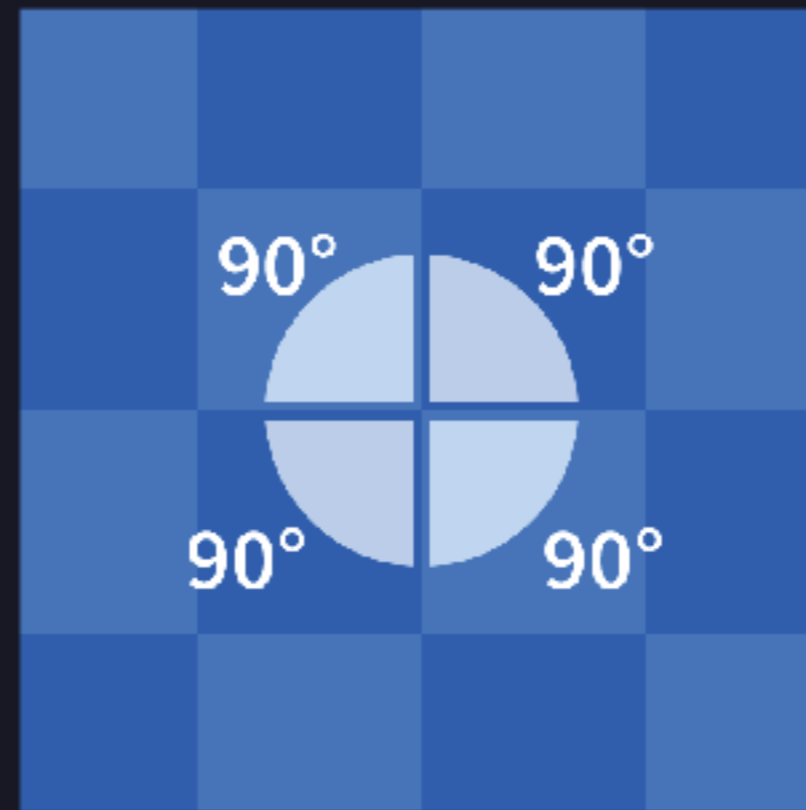
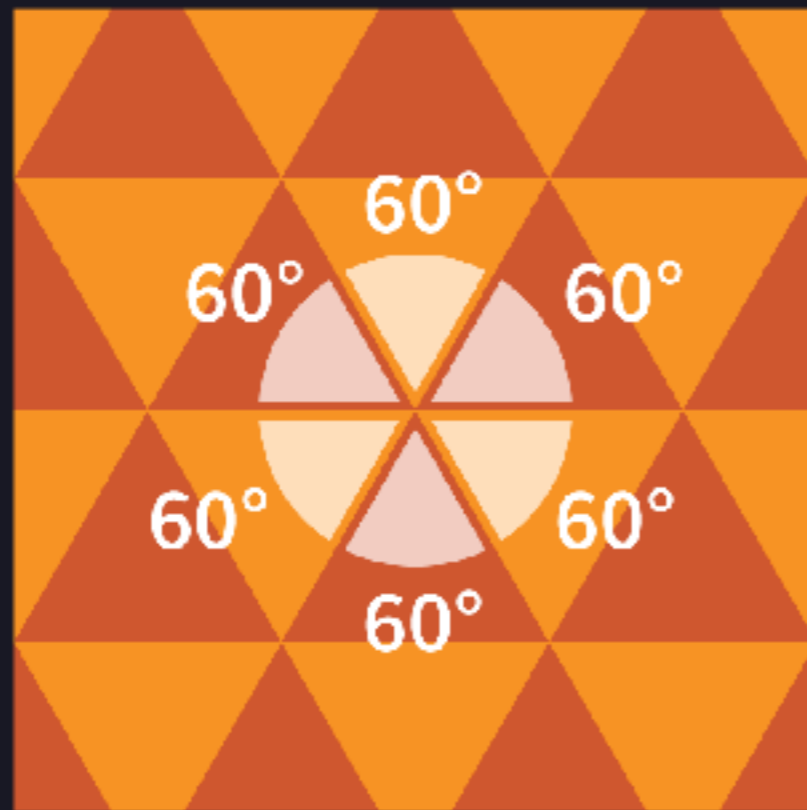


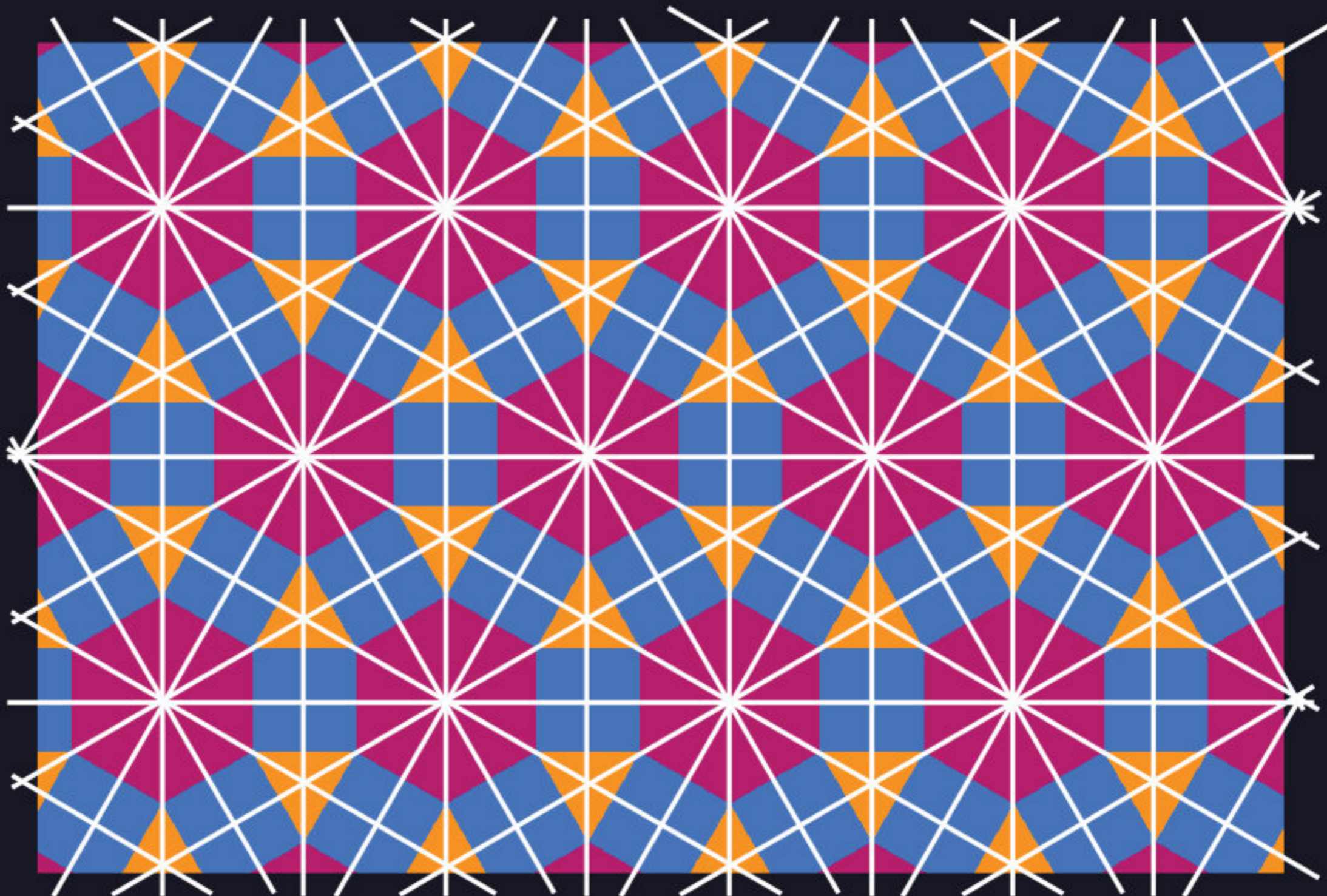
### NUMBER TILES



### NUMBER BARS









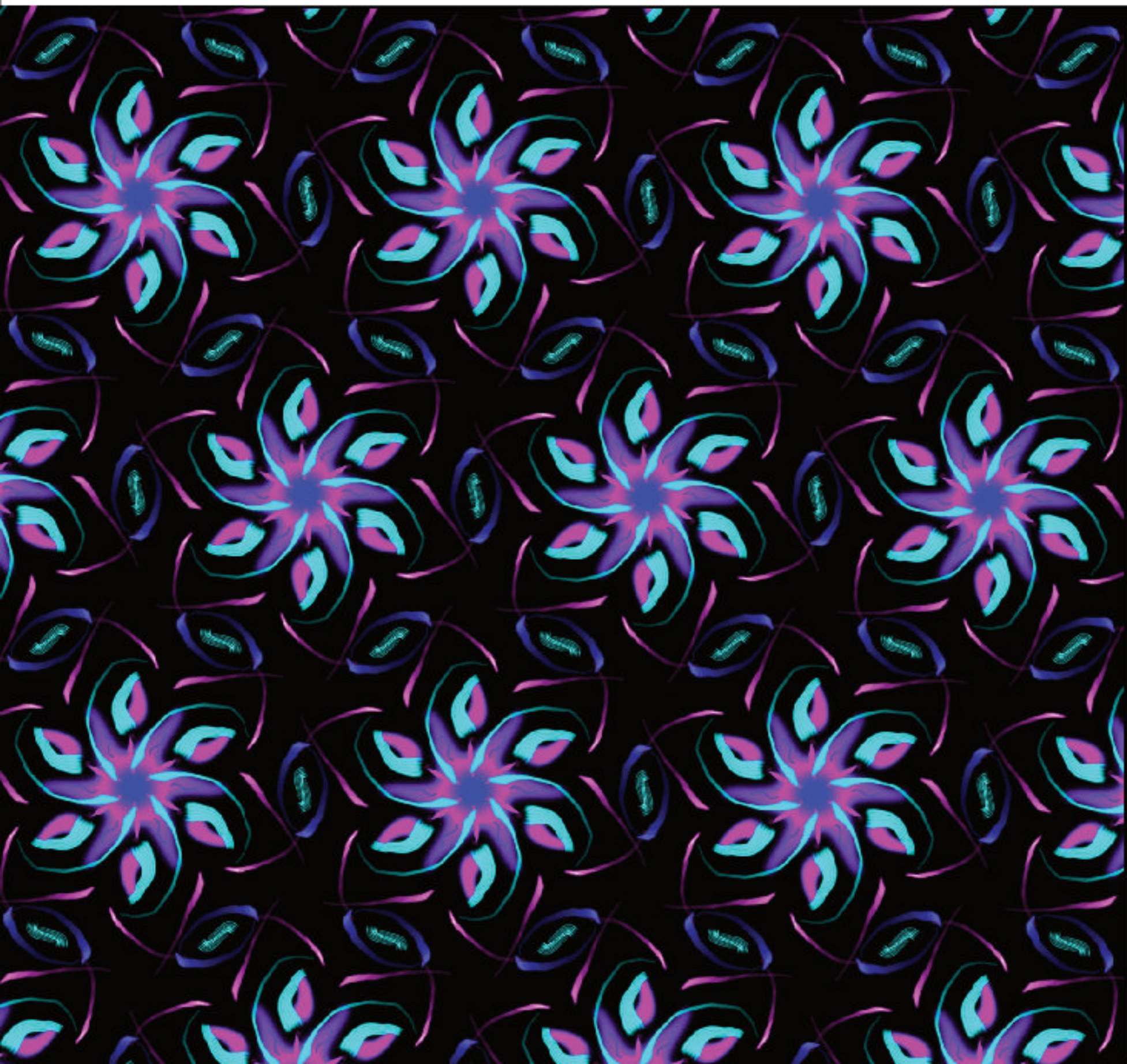
# 17 Wallpaper Groups



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Download Clear

A vertical color palette on the right side of the wallpaper features several colored circles. The green circle is currently selected, indicated by a blue square border around it.



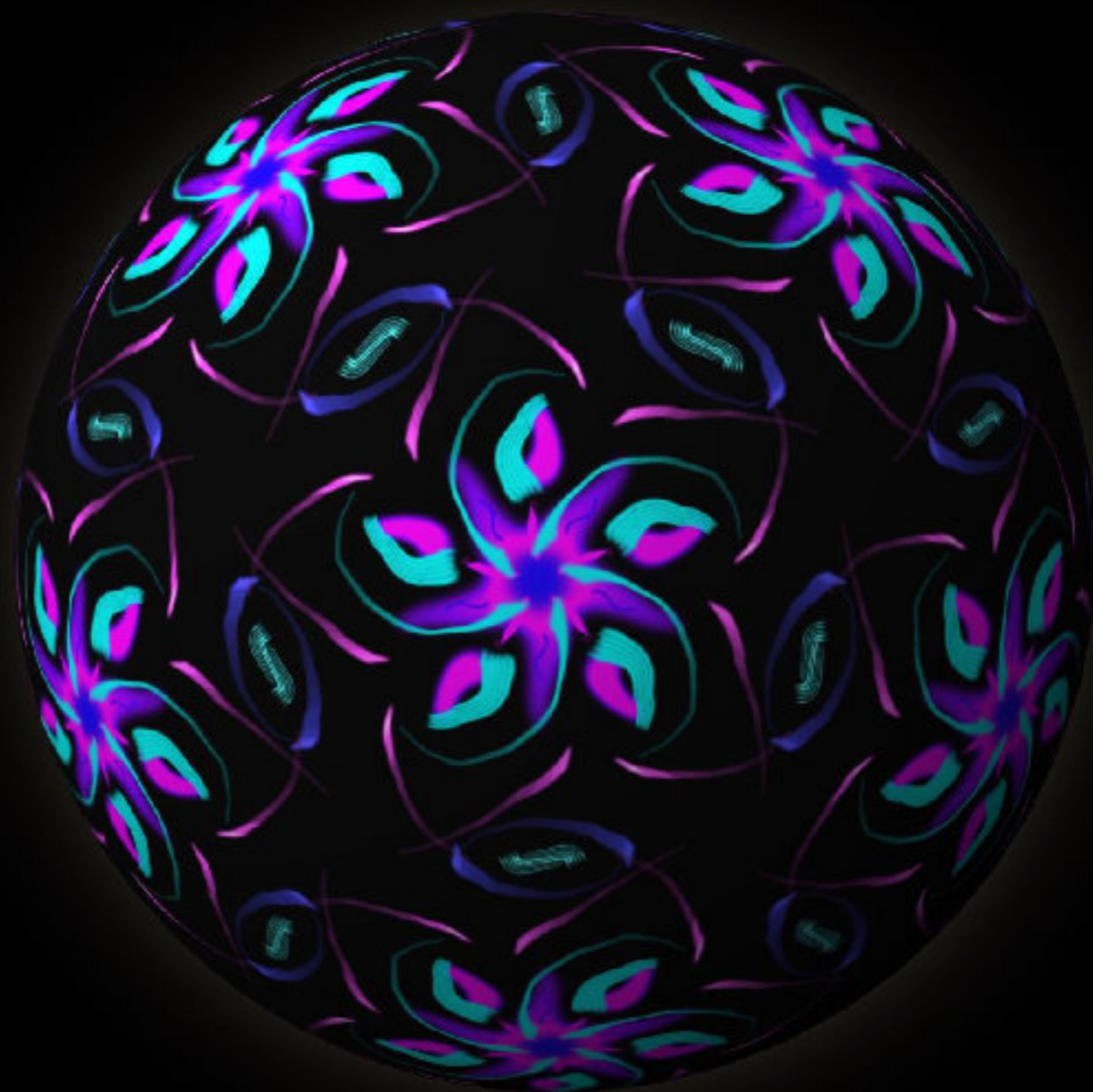
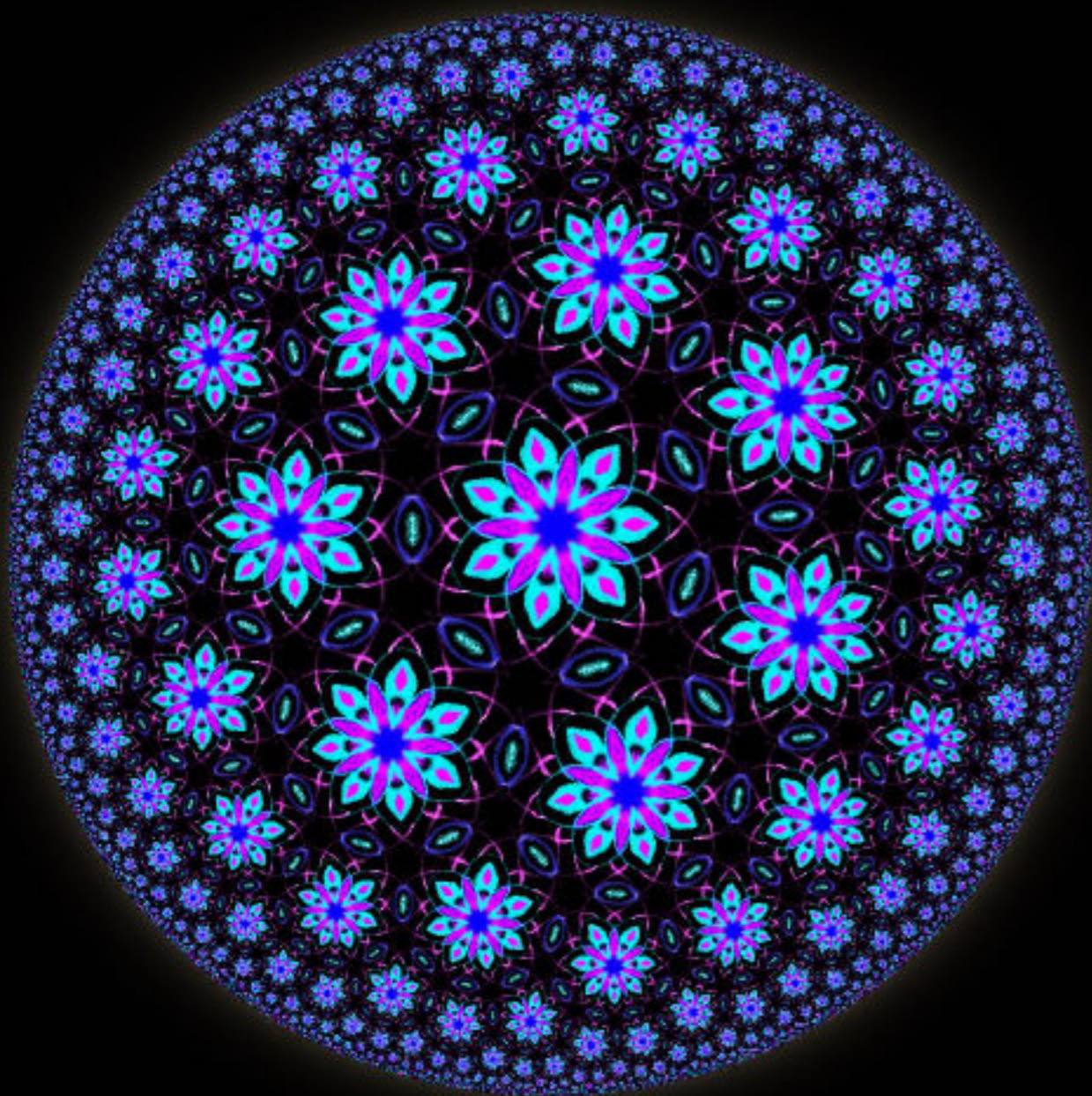
The interface includes a color palette with 12 color swatches: red, orange, yellow, green, cyan, blue, dark blue, purple, magenta, pink, white, and black. Below the palette are four sliders for adjusting pattern properties. A grid of 20 pattern thumbnails is displayed, with the selected pattern highlighted. The selected pattern is labeled "Name: P6" and "Orbifold: 632". A lightbulb icon indicates a tip. The interface also features a home button, a search icon, a question mark, a tip icon, a settings gear, a camera icon, a refresh icon, a trash can, and a stack of papers icon.

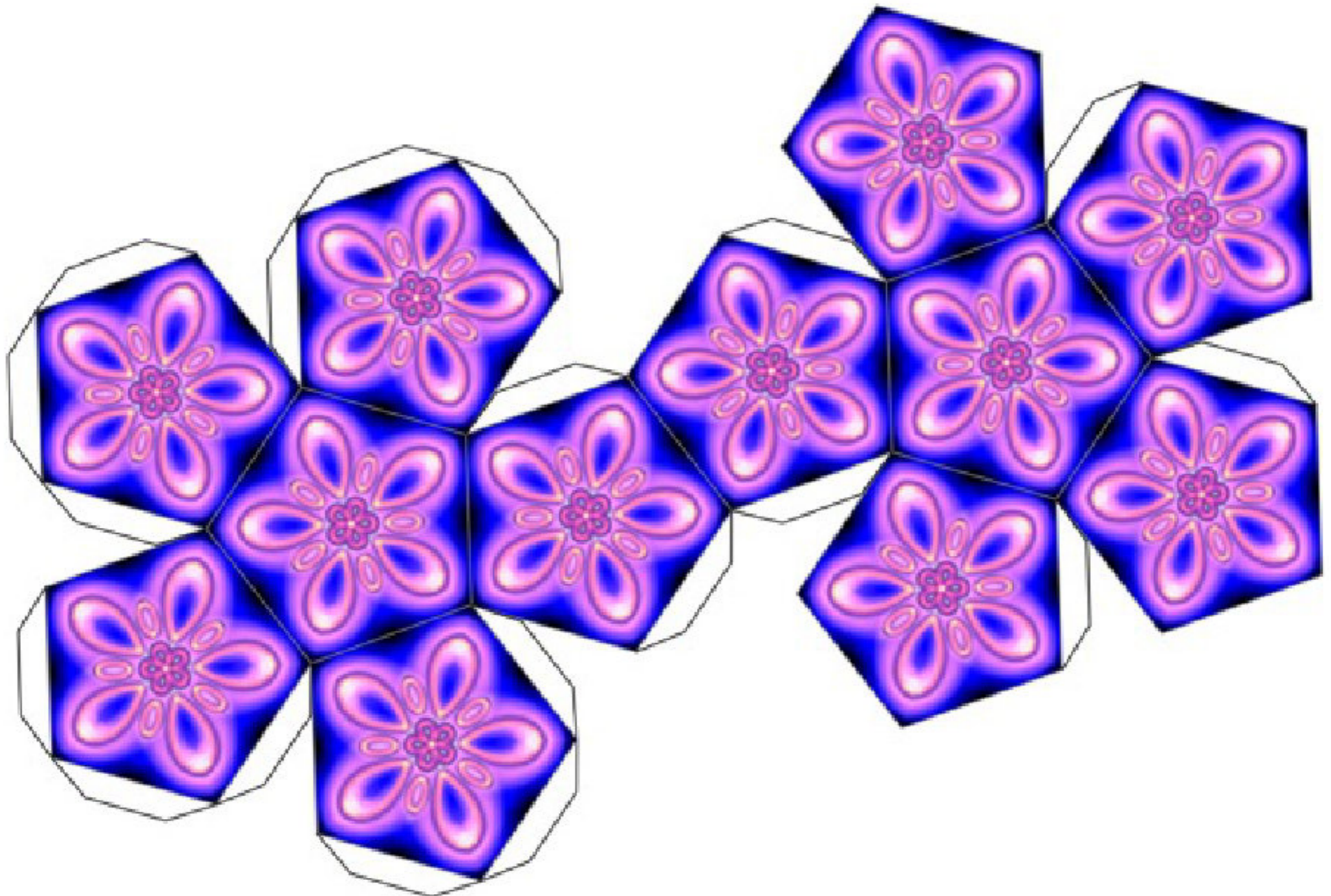




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*science-to-touch.com* – \$3.99



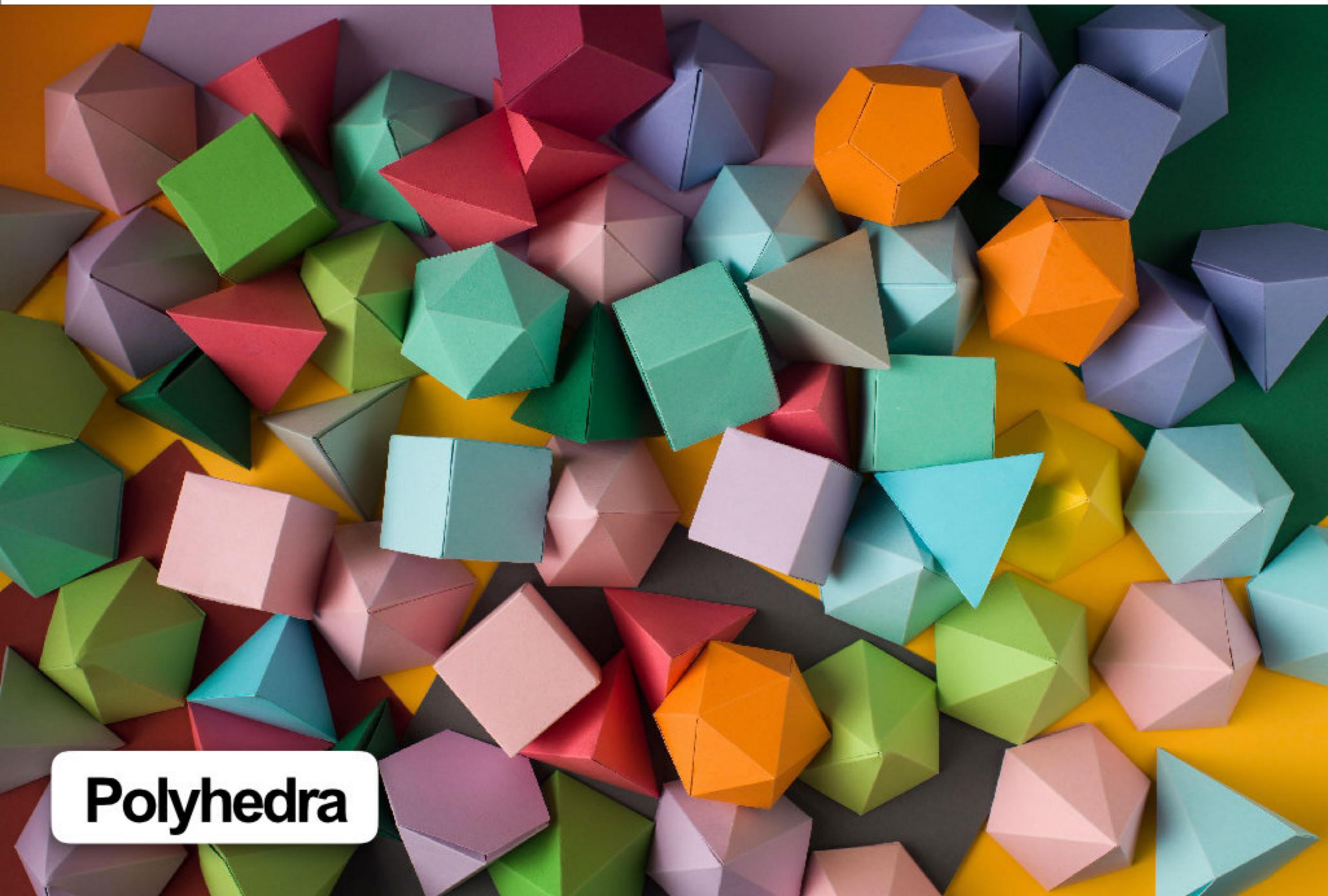




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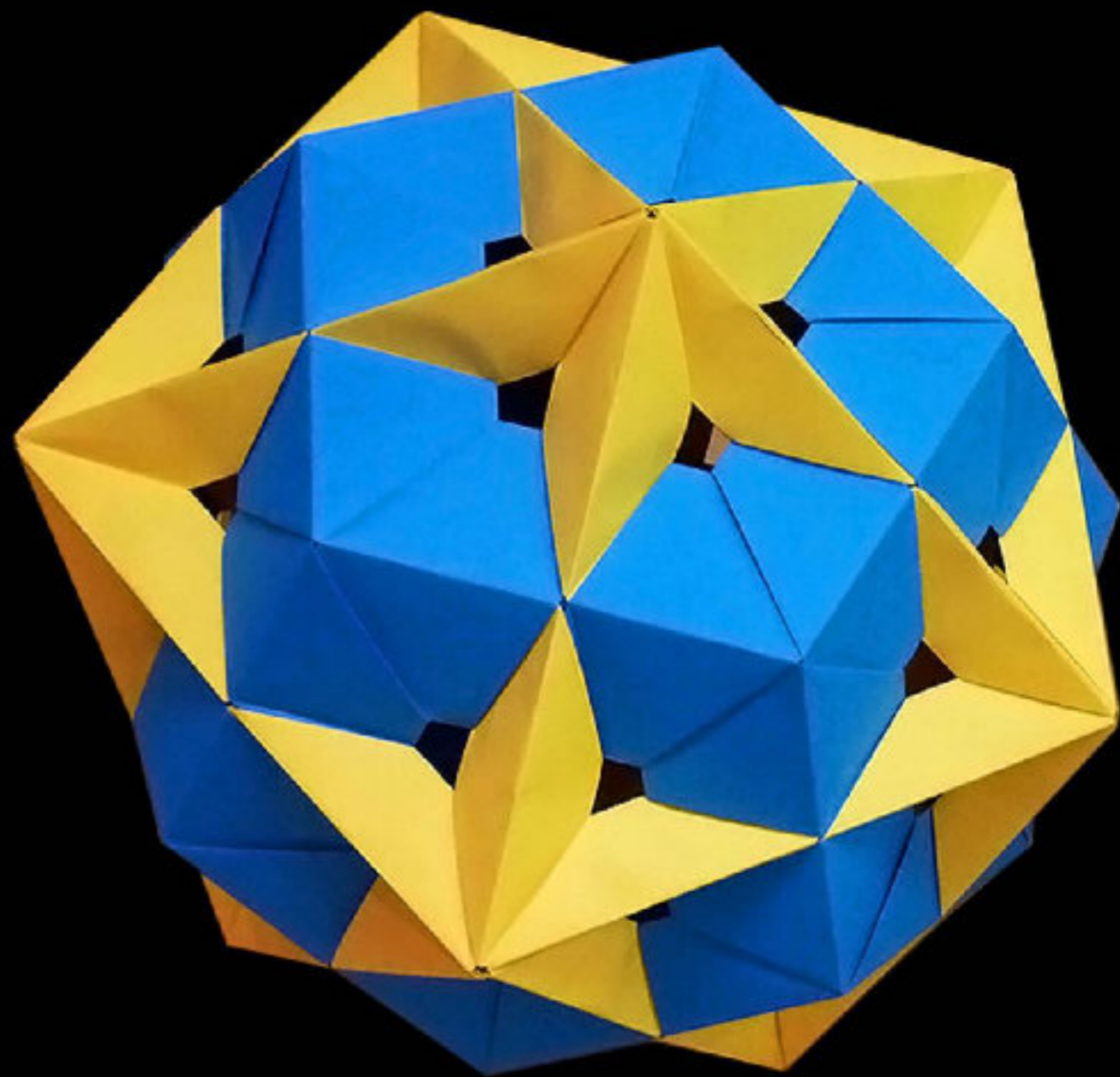


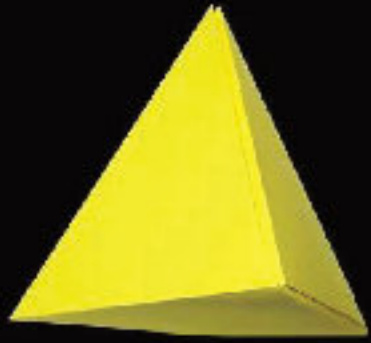


# Polyhedra



**Volume**  
**Surface Area**  
**Nets/Cross Sections**  
**Euler's Formula**  
**5 Platonic Solids**

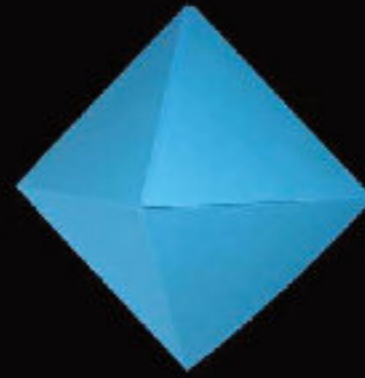




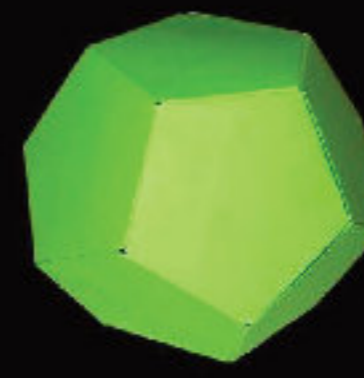
Tetrahedron



Cube



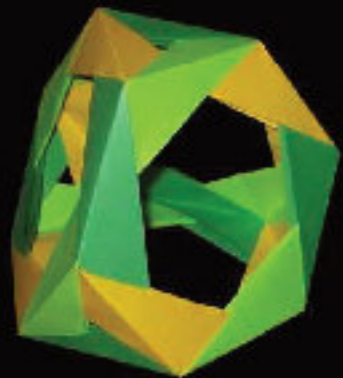
Octahedron



Dodecahedron



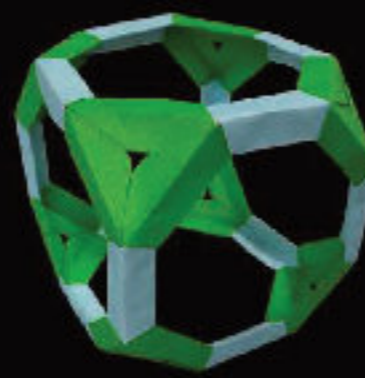
Icosahedron



Truncated Tetrahedron



Cuboctahedron



Truncated Hexahedron



Truncated Octahedron



Intersecting Tetrahedra



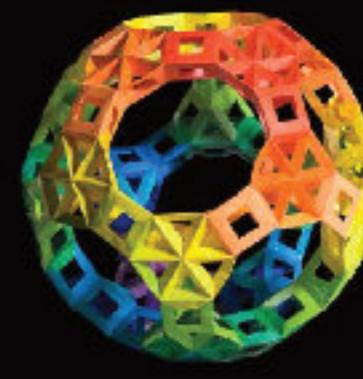
Truncated Cuboctahedron



Snub Cube



Icosidodecahedron



Truncated Icosidodecahedron



Snub Dodecahedron

MATHIGON ORIGAMI  
**DRAGONS** ★ ★ ★

more on [mathigon.org/origami/](http://mathigon.org/origami/)

This model requires one quadratic sheet of paper.


© Mathigon.org

MATHIGON ORIGAMI  
**RHOMBICOSIDODECAHEDRON**

more on [mathigon.org/origami/](http://mathigon.org/origami/)

14 Faces  
(Triangles and Squares)  
24 Edges  
12 Vertices

© Mathigon.org

MATHIGON ORIGAMI  
**5 INTERLOCKING TETRAHEDRA** ★ ★ ★ ★

more on [mathigon.org/origami/](http://mathigon.org/origami/)

This model consists of the interlocking frames of 5 tetrahedra. It is one of the most difficult models on Mathigon.org, but also the most impressive.

Every tetrahedron is made out of six strips of paper with dimensions in the ratio 1:3. These can be created by cutting a square into three parts. We recommend that you use different colours for every tetrahedron, which means you need two squares in each of 5 colours.

Once you have created all  $5 \times 6 = 30$  strips, they each need to be folded as follows:




Each of these 30 units will form the edge of one tetrahedron. At every vertex, three units link together:

--	--	--	--

Now start connecting all units colour by colour, to form the 5 interlocking tetrahedra.

--	--	--	--

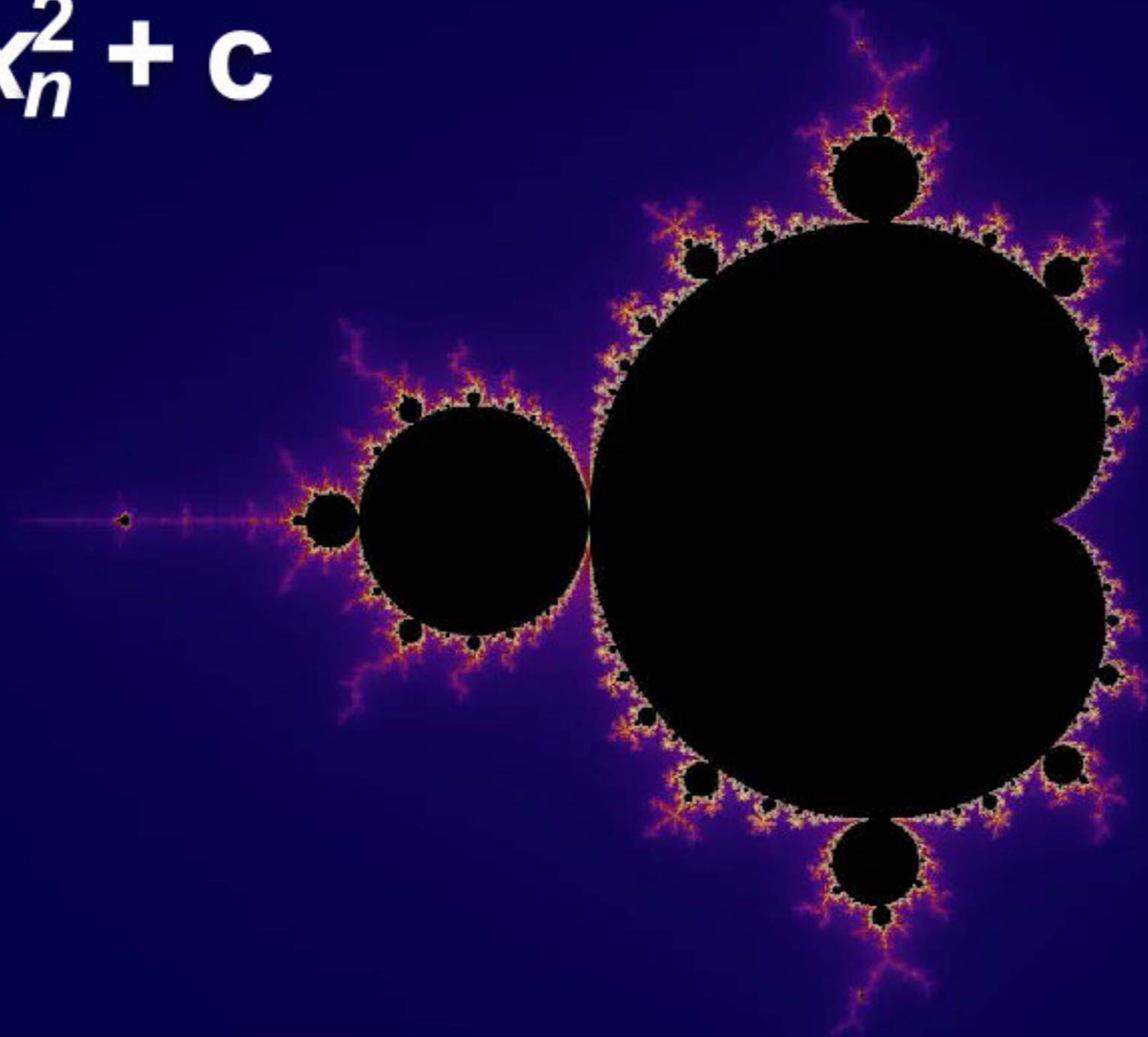
© Mathigon.org



**Intersecting Tetrahedra**



$$x_{n+1} = x_n^2 + c$$

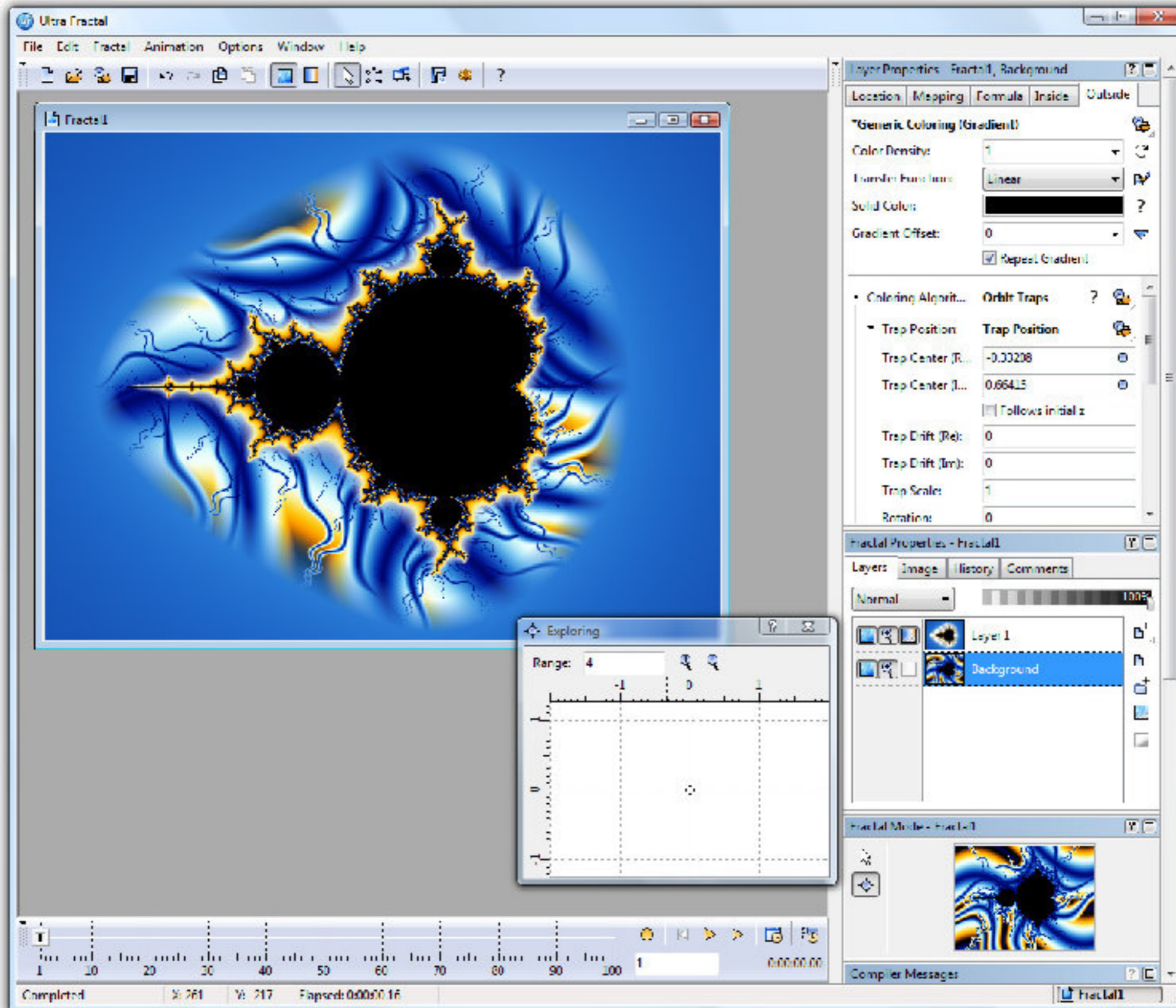


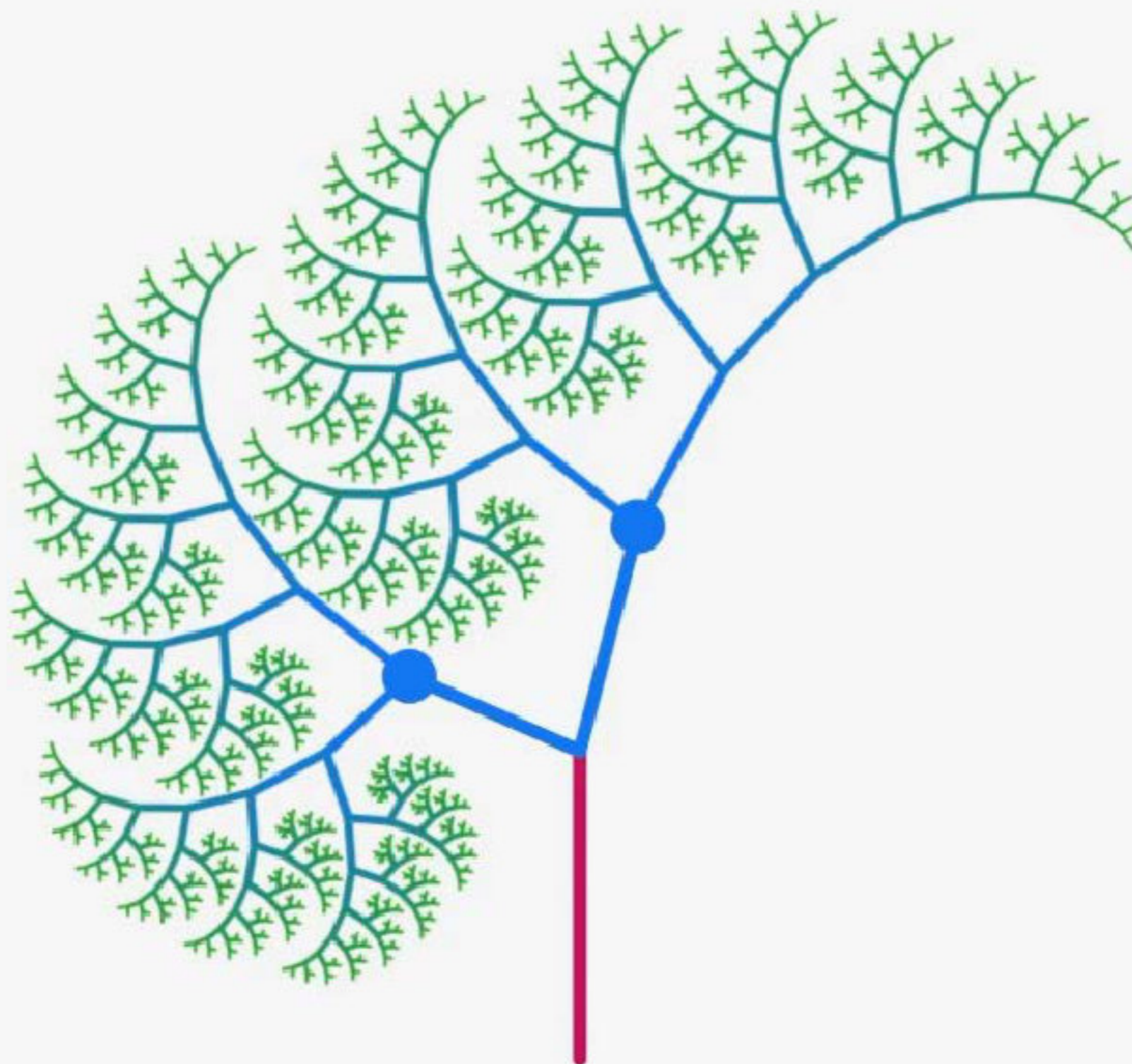
**Mandelbrot Set**



```
MandelComp = Compile[
  {{c, _Complex}},
  Module[{num = 1},
    FixedPoint[(num++; #^2 + c)&, 0, 8191, SameTest->(Re[#]^2 + Im[#]^2 >= 4 &)] ;
    num],
  CompilationTarget->"C",
  RuntimeAttributes->{Listable},
  Parallelization->True
];
```

```
Mandelbrot[x_, y_, m_] := ArrayPlot[
  MandelComp[Table[a + I b,
    {b, y - 2.7 * 2^-m, y + 2.7 * 2^-m, 0.005 * 2^-m},
    {a, x - 4.8 * 2^-m, x + 4.8 * 2^-m, 0.005 * 2^-m} (*0.002*)
  ]] / 8192,
  ColorRules->{1->Black},
  ColorFunction->MandelColor,
  ColorFunctionScaling->False,
  Frame->False,
  PixelConstrained->1
];
```





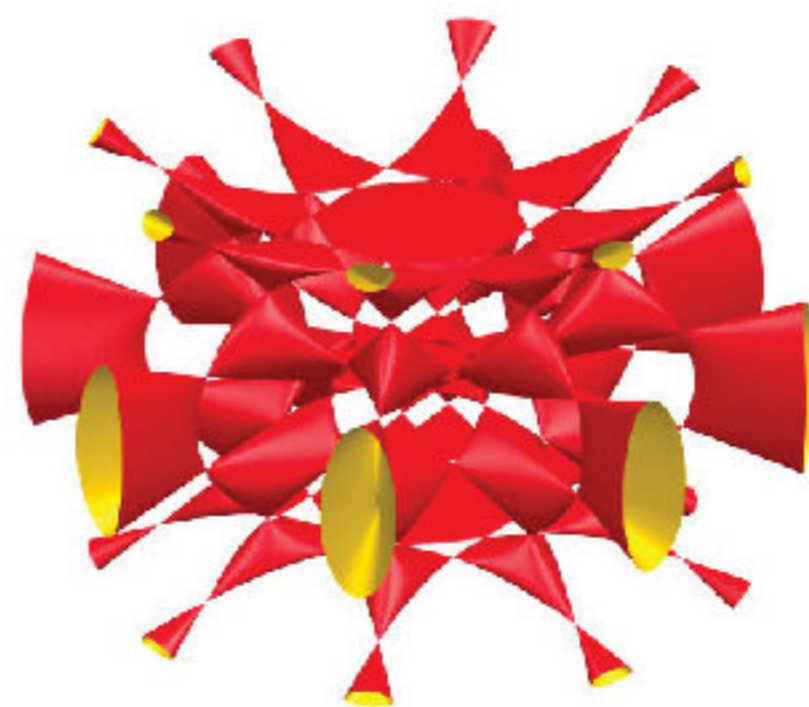
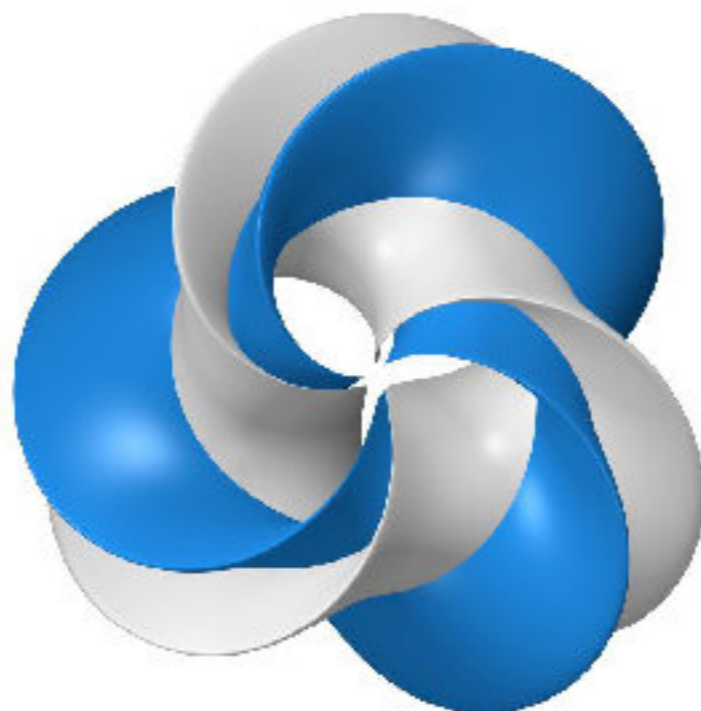
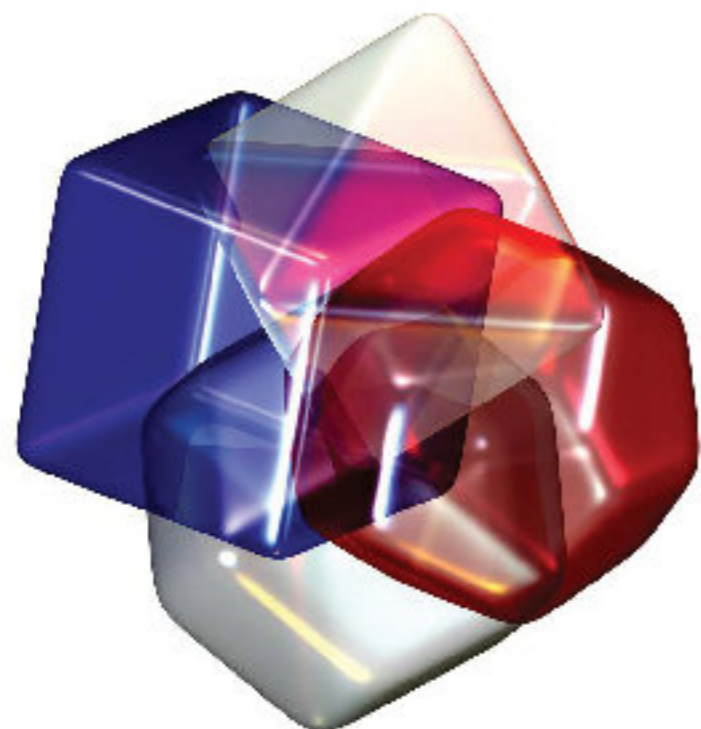
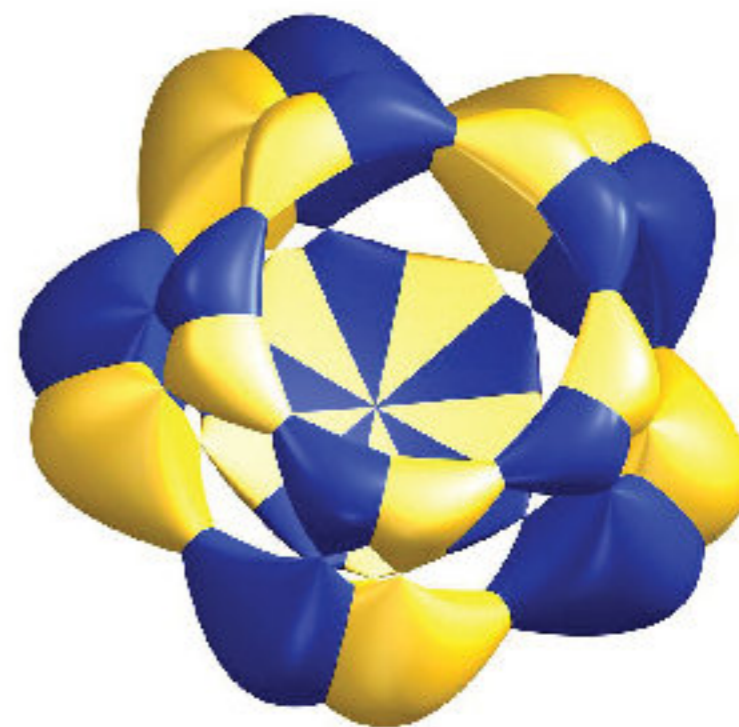




$$(x^2 + 9/4 \cdot y^2 + z^2 - 1)^3 - x^2 \cdot z^3 - 9/80$$



$$x^3 + x^2 \cdot z^2 - y^2$$





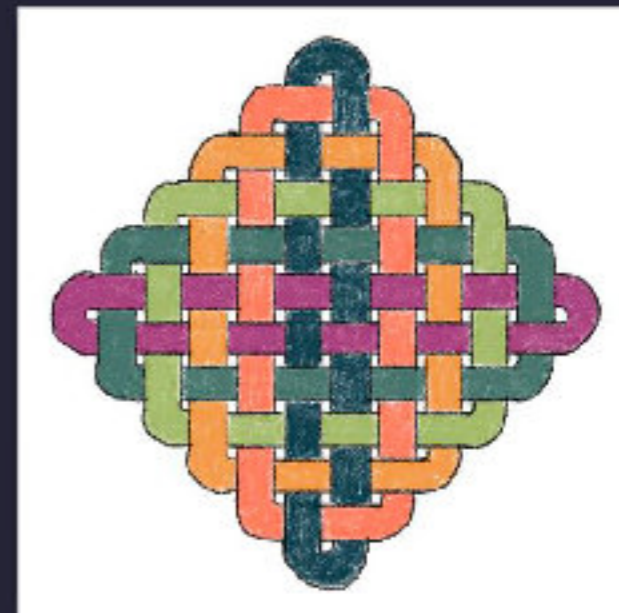
# #MathArtChallenge



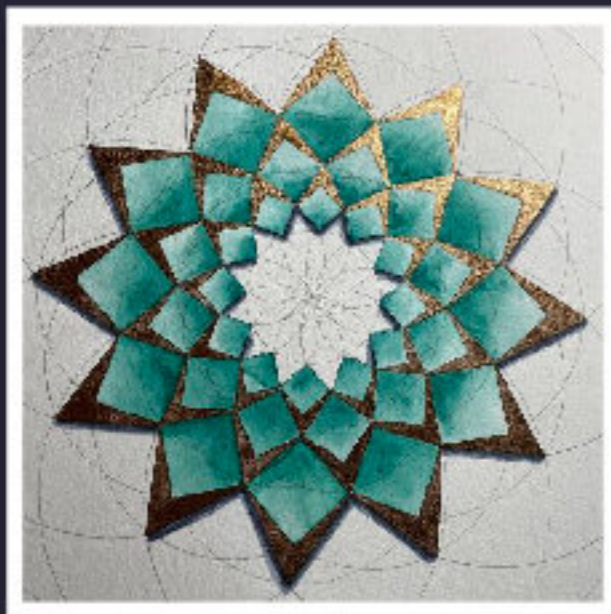
*@KjerstiFried*



*@RosieTChen*



*@jayproffitt*



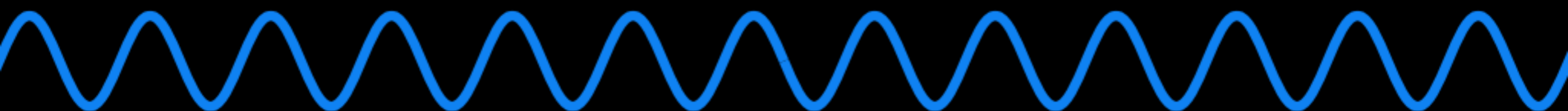
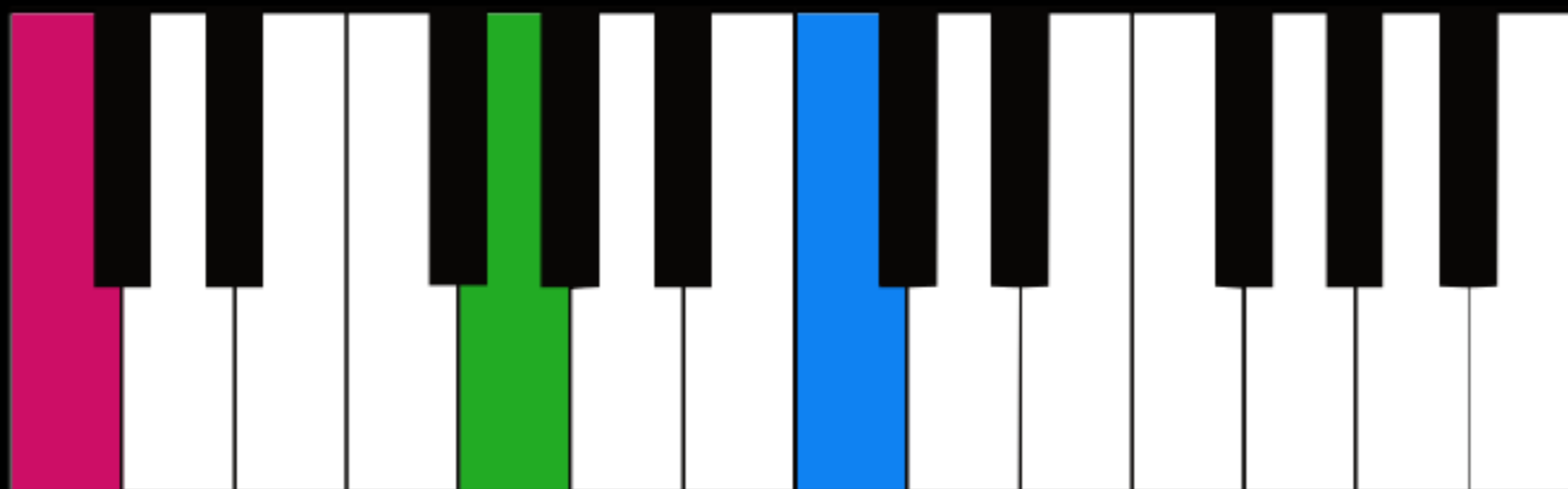
*@anniek\_p*



*@Cshearer41*



*@bquentin3*

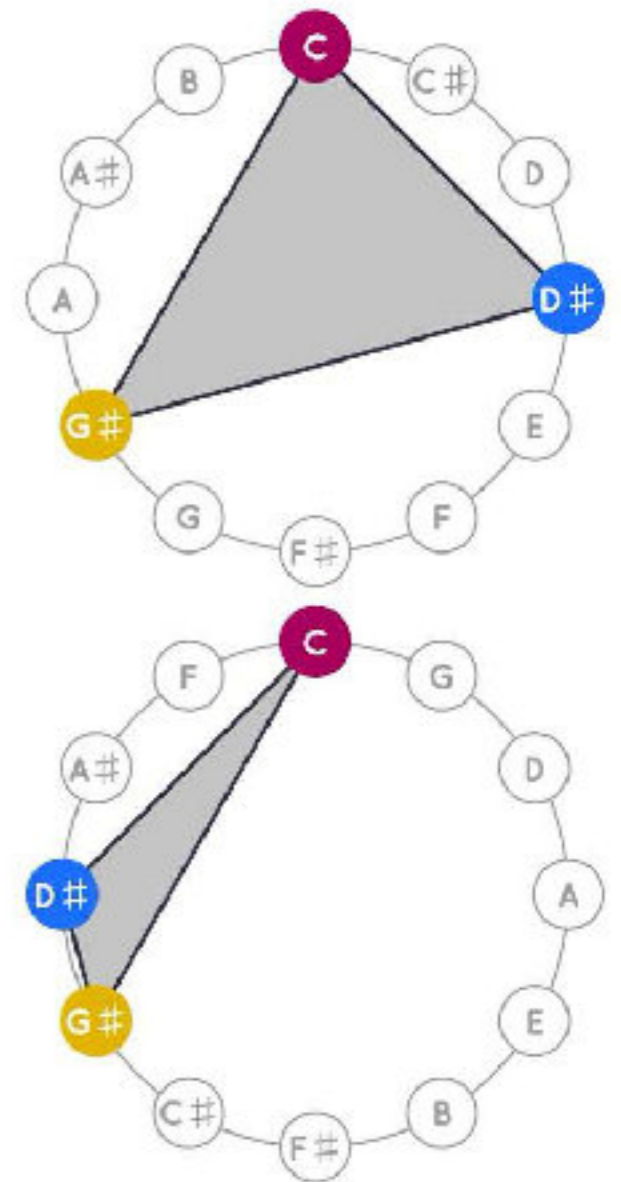
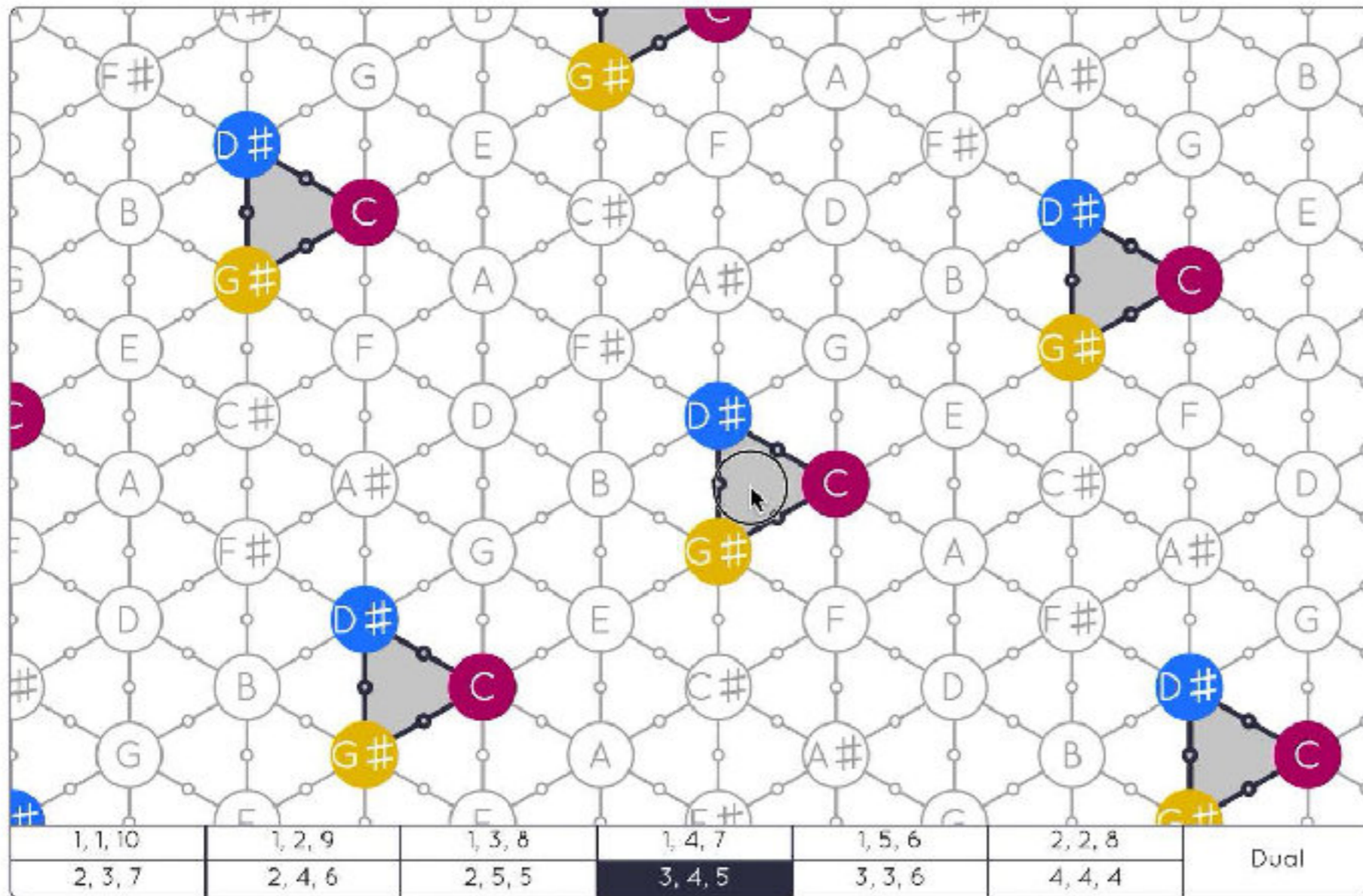


$$\sqrt[12]{2}$$

$$1.4983\dots \approx 1.5$$

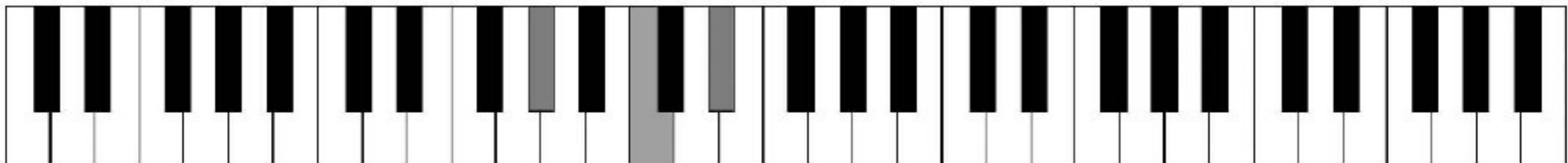


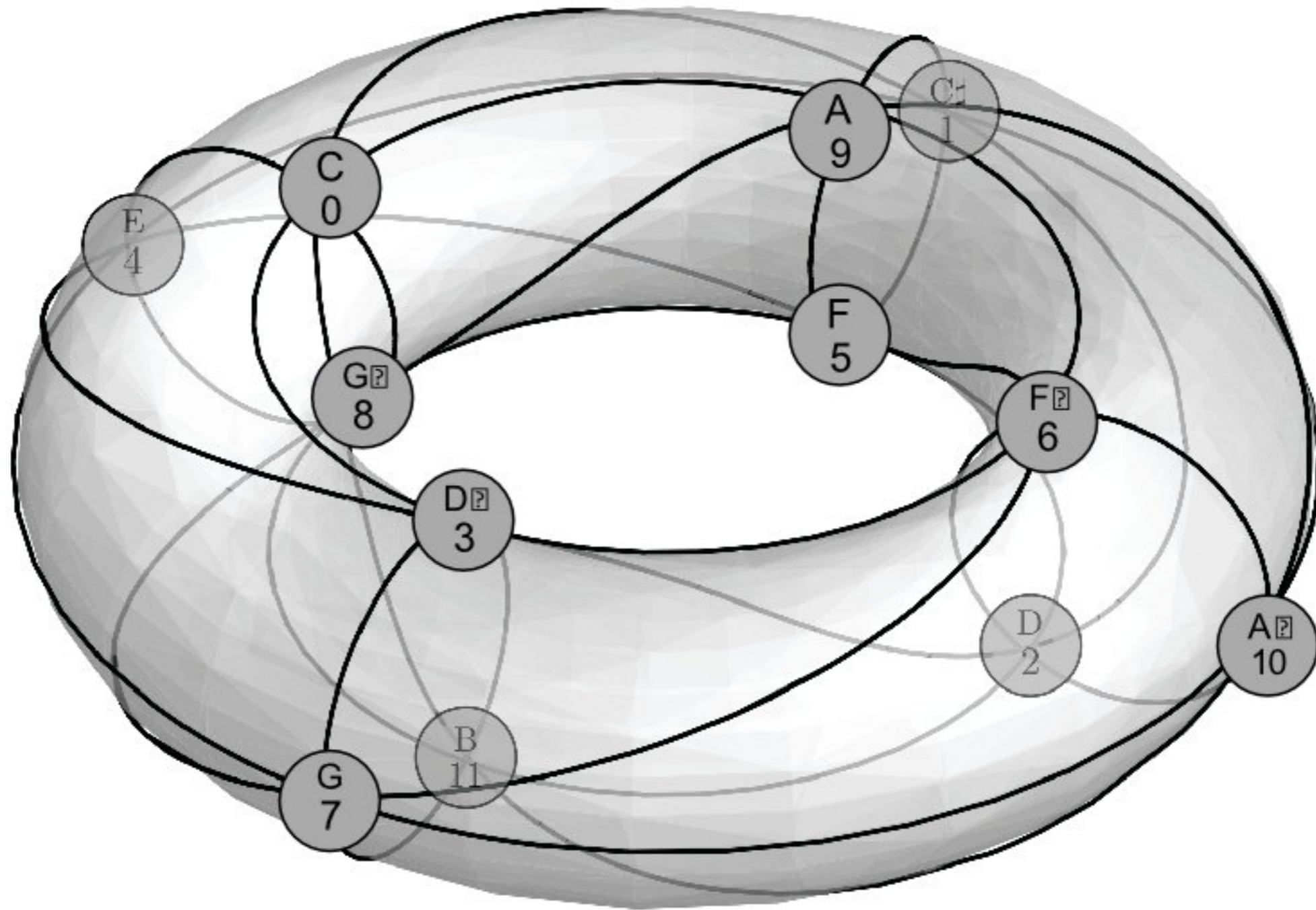




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# Creativity is Problem Solving!



Reduce complex problems to their essentials and discover patterns.



Express situations using new or different representations.



Recognise implicit assumptions and think outside the box.



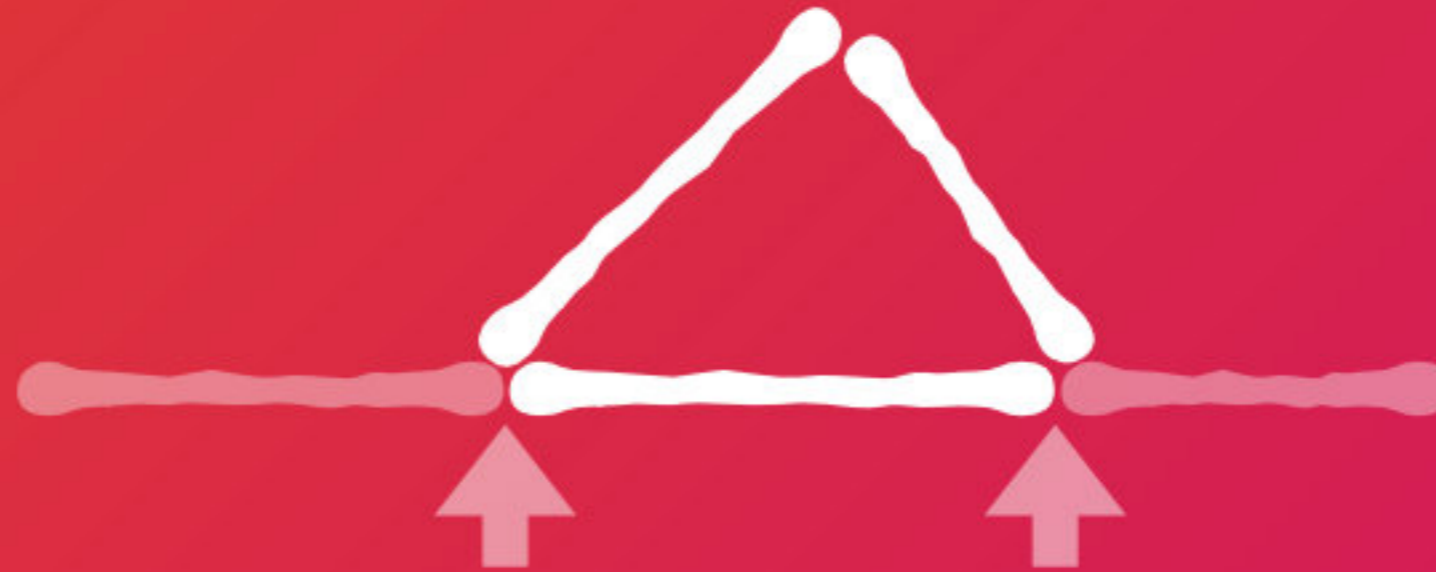
Combine tools and results from different parts of mathematics.



You break a stick in two different places, uniformly at random. What is the probability that the three resulting pieces form a triangle?



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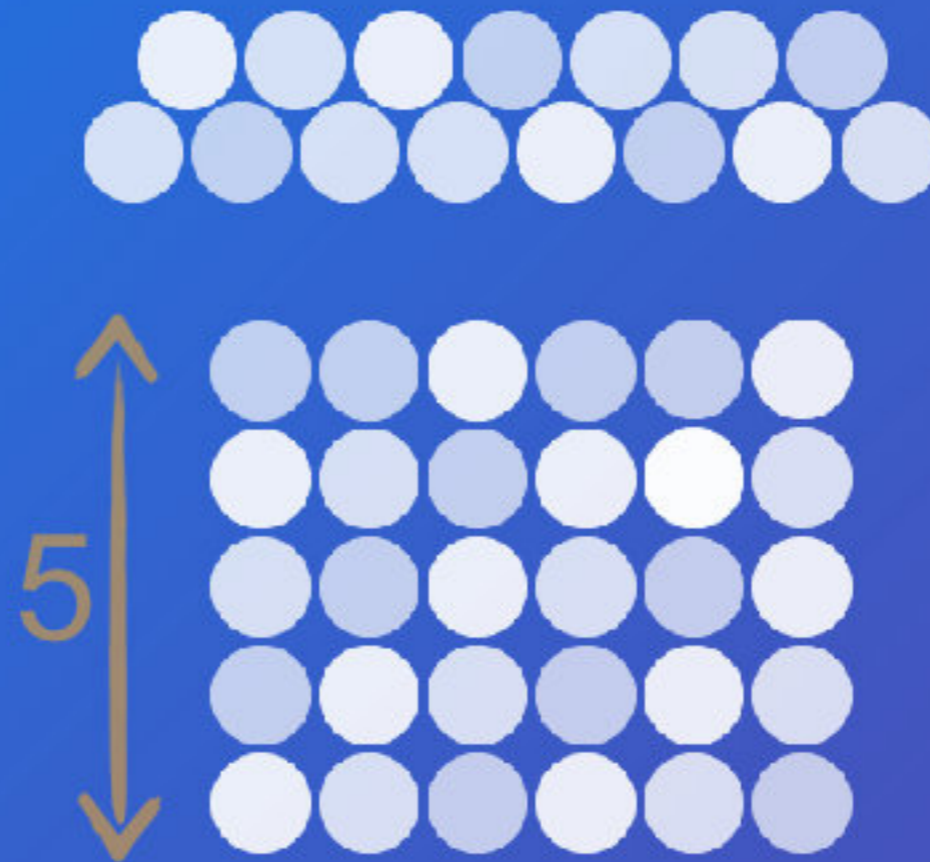


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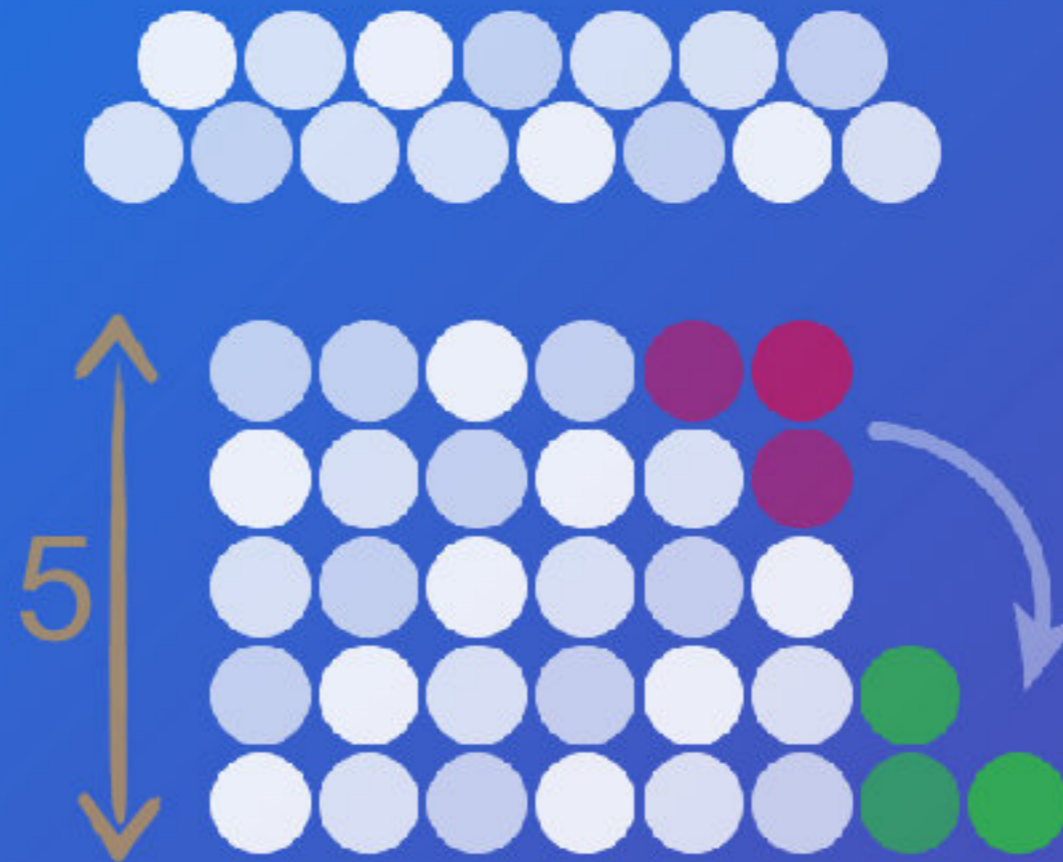




Here are some *Trapezium Numbers*. There is just one number between 1000 and 2000 that *doesn't* form a Trapezium. Which one?



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1  
How many ways are there to tile a rectangle of size  $2 \times 10$  with dominoes?

2  
A semicircle lies inside a square. What proportion of the square is shaded?

3  
There are 20 strings in a bag. You randomly pick two ends and tie them together, until there are no free ends left. What is the expected number of loops you will create?

4  
Rearrange these numbers and symbols to make a true equation:

$$2 \ 3 \ 4$$

$$5 \ + \ =$$

5  
What is the least number of integers needed, so that any of these could be true?

Median < Mean < Mode  
Median < Mode < Mean  
Mode < Median < Mean  
Mean < Mode < Median  
Mean < Median < Mode

6  
How many ways are there to distribute 10 identical cookies between five different kids?

Kids don't need to receive the same number of cookies.

7  
Can you plant 7 trees so that there are 6 straight lines containing 3 trees each?

8  
What is the value of  $x$ ?

$$x + x + x + x = 2$$

9  
A castle is surrounded by a 5 meter wide, rectangular moat. Can you cross it using nothing except two planks that are 4.8 meters long?

10  
I repeatedly toss a fair coin and record the outcome. What is the probability that the sequence "HHH" occurs before "THH"?

11  
Every frog jumps into an adjacent square (left, right, up or down). What is the largest number of squares that could become empty?

12  
Can the locomotive L switch the position of the two wagons and end up where it started? Only the locomotive can fit under the bridge.

13  
You have 10 cans of peas. All peas weigh 1 gram, except for one can with peas that weigh 0.9 grams. How often do you need to use a scale to find this lighter can?

14  
Can you arrange the seven Tetriminoes in a  $7 \times 4$  rectangle, with no gaps or overlaps?

15  
Scientists are studying a micro-organism, starting with a single cell. Every day, each cell either splits in two (with probability  $p$ ), or it dies. What is the probability that the entire organism dies eventually?

16  
Continue this sequence:

6 10 14 15

21 22 26 33

34 35 ? ?

17  
What's the angle between these congruent equilateral triangles?

18  
Three geysers A, B and C in a national park erupt every 1, 2 and 3 hours respectively. You just arrived: what is the probability that you will see geyser A erupt first?

19  
Can you place 18 black and 18 white tiles on a  $6 \times 6$  board, so that there are no "squares" with their four corners having the same colour?

20  
What 4-digit number, when multiplied by 4, reverses its digits?

$$ABCD \times 4 = DCBA$$

7<sup>0</sup> 4 1 6 3 3

21  
What proportion of a square is closer to its centre than its edge?

22  
Can you measure exactly 15 minutes using nothing but an 11-minute hourglass and a 7-minute hourglass?

23  
You pick three random points on a circle. What is the probability that the resulting triangle contains the center of the circle?

24  
This is the most efficient way to place three congruent squares in an equilateral triangle. What proportion of the triangle is shaded?



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# Resources

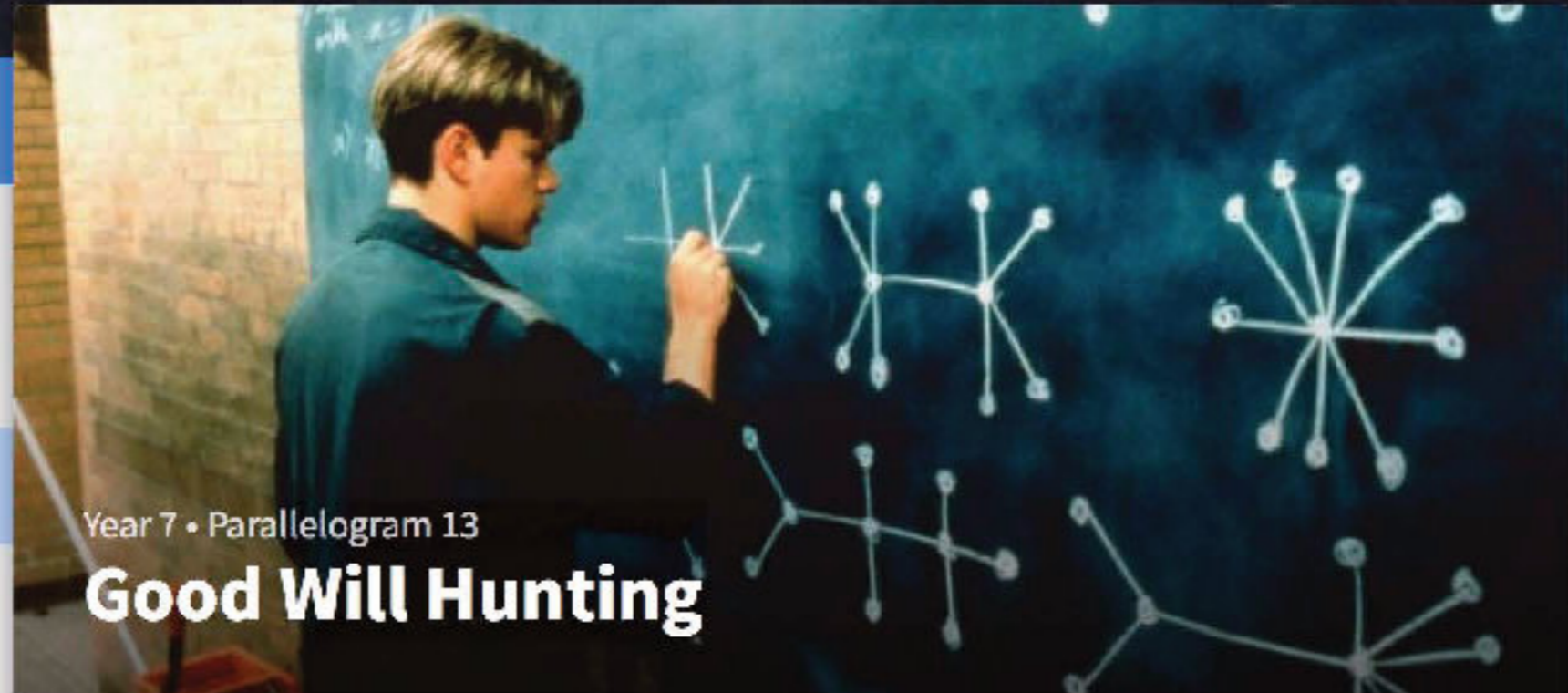
# parallel

by Simon Singh

## Philipp Legner

Year 7 • Edit Account • Logout

- WEEK 15  
Blackboard Equation
- WEEK 14  
Sumaze
- WEEK 13  
Good Will Hunting
- WEEK 12  
Maths Jokes
- WEEK 11  
The Secret of Happiness
- WEEK 10  
A matter of factorial!
- WEEK 9  
Easter challenges
- WEEK 8  
Tricky parking problem
- WEEK 7  
Optimising your pizza money



Year 7 • Parallelogram 13

## Good Will Hunting

**Noun:** Parallelogram **Pronunciation:** /ˌparəˈleləɡrəm/

1. a portmanteaux word combining parallel and telegram. A message sent each week by the Parallel Project to bright young mathematicians.

There are only 3 more Parallelograms this year, as we will be starting our summer break at half-term. If you score highly enough in the last 4 Parallelograms (#12, this one, #14 & #15) by June 1, **then you will receive a Parallel certificate**. An average of more than 40% in these four Parallelograms wins a bronze certificate, then 60% or more wins silver



NRICH



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### Teachers



Free resources and curriculum mapping documents

[Early Years](#)

[Primary](#)

[Secondary, Post 16 and STEP](#)

### Primary Pupils



The tasks in [this feature](#) encourage you to play and explore, then think deeply about the mathematical ideas underneath.

See all problems [Open for Solution](#)

See all [Resources for ages 5-11](#)

### Secondary Students



In [this feature](#), explore the problems and then try to explain what's going on!

See all problems [Open for Solution](#)

See all [Resources for ages 11-18](#)

### Events and PD



### Your Solutions



### Tweets by @nrichmaths

NRICH maths Retweeted

**Liz Woodham**  
@omw1001

First day of @nrichmaths PD with a new group of primary teachers from Tower Hamlets. Six days focusing on whole class reasoning. And I get to work with @FranMaths too. Woo hoo

## Welcome To Plus Magazine!



## Welcome to the FIFA World Cup!

From making penalties fairer or taking the perfect free kick, to designing an ideal ball and predicting results using an octopus, it's all there in our collection of football articles. Take your pick!



### Genetics: Nature's digital code

Is nature using digital tools to deal with genetic information?



### Maths in a minute: Chomp

Explore a game that involves biscuits and comes with a surprising mathematical twist — what could be better?



### The real numbers and Cauchy sequences

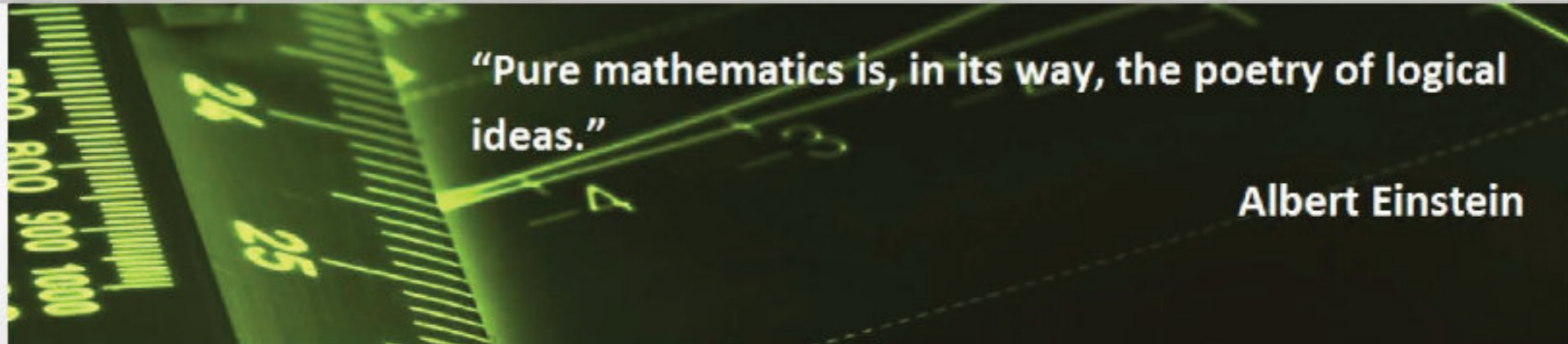
We take the real numbers for granted, but what are they really? Here's an interesting way



### Clocking the schedule

The way many football leagues schedule their fixtures can lead to unfair effects — and unsolved maths problems! Dries





### Featured Articles



#### Which Degree Courses need A-level Mathematics?

A-level Mathematics is one of the most widely accepted and respected subject choices by universities. Read about how it can enhance your course options.

[Read the full](#)

### Recent Articles



#### Joint degrees including mathematics

Choosing what to study at university can be hard. Lots of students choose to study joint degrees, where they study more than one subject.

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#### Depaak Mahta - Data Scientist and Community manager

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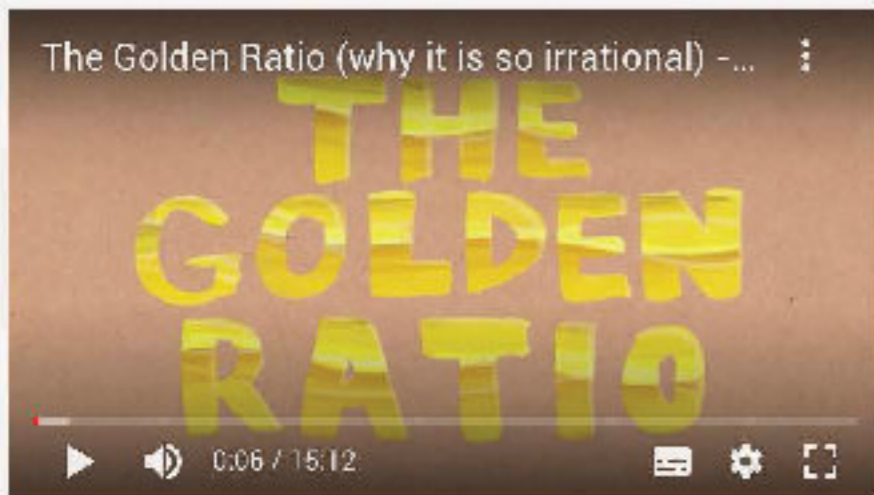
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Lewis Carroll's Pillow



Why is this Puzzle



The Daddy of Big Numbers

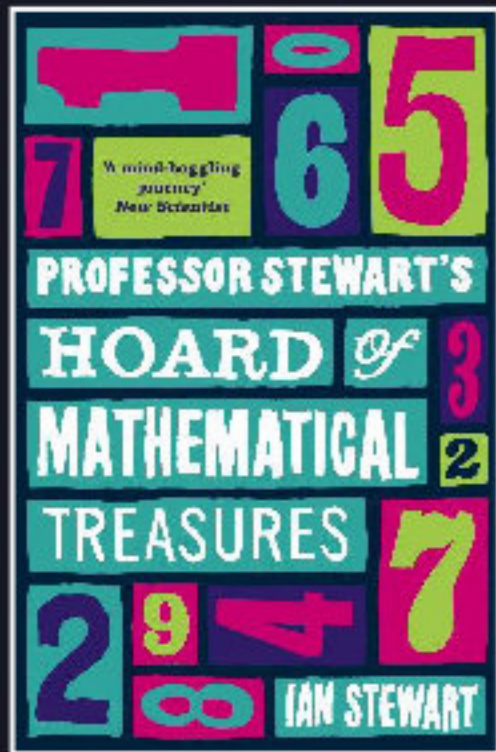


Impossible Squares -

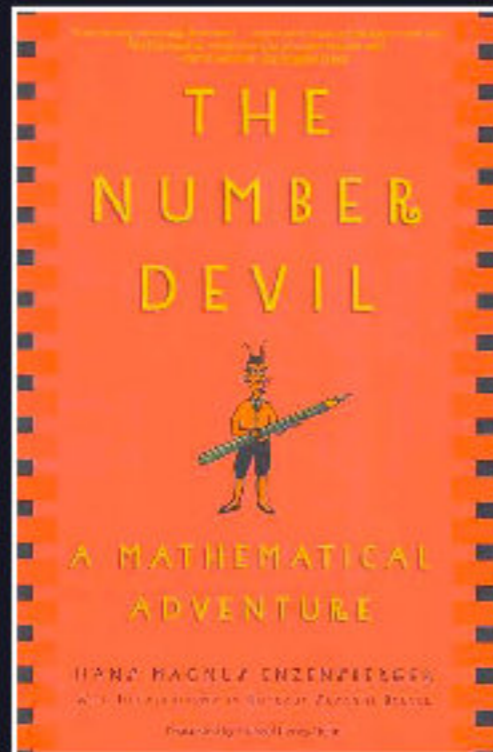


Mathematics and

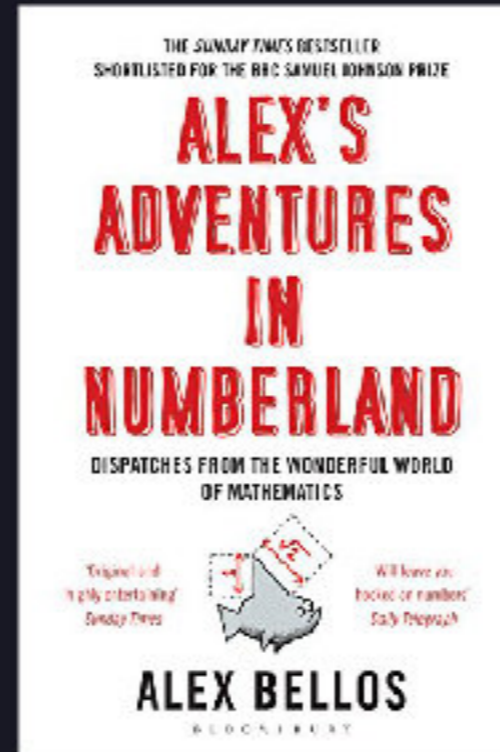
# Popular Mathematics Books



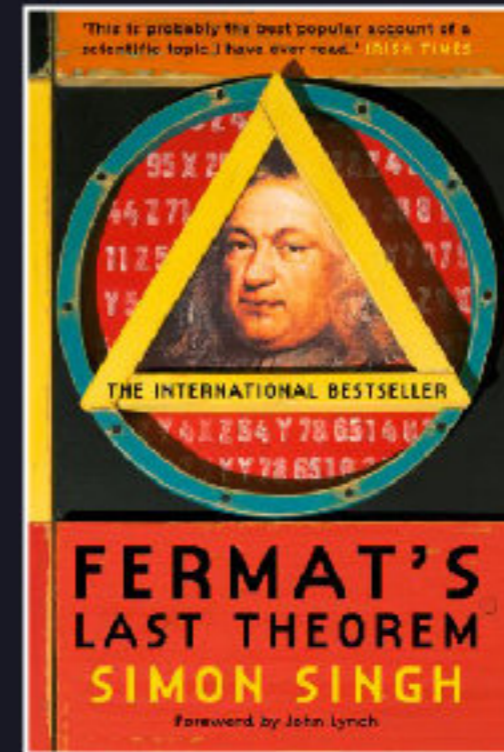
Ian Stewart



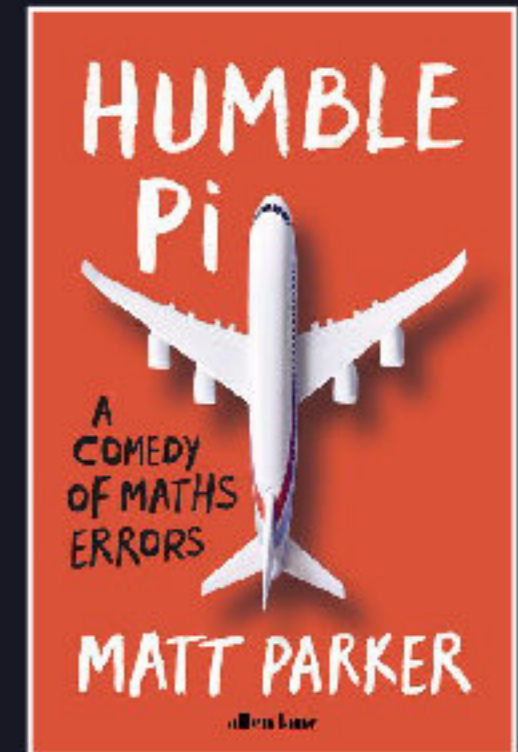
Hans Magnus  
Enzensberger



Alex Bellos



Simon Singh



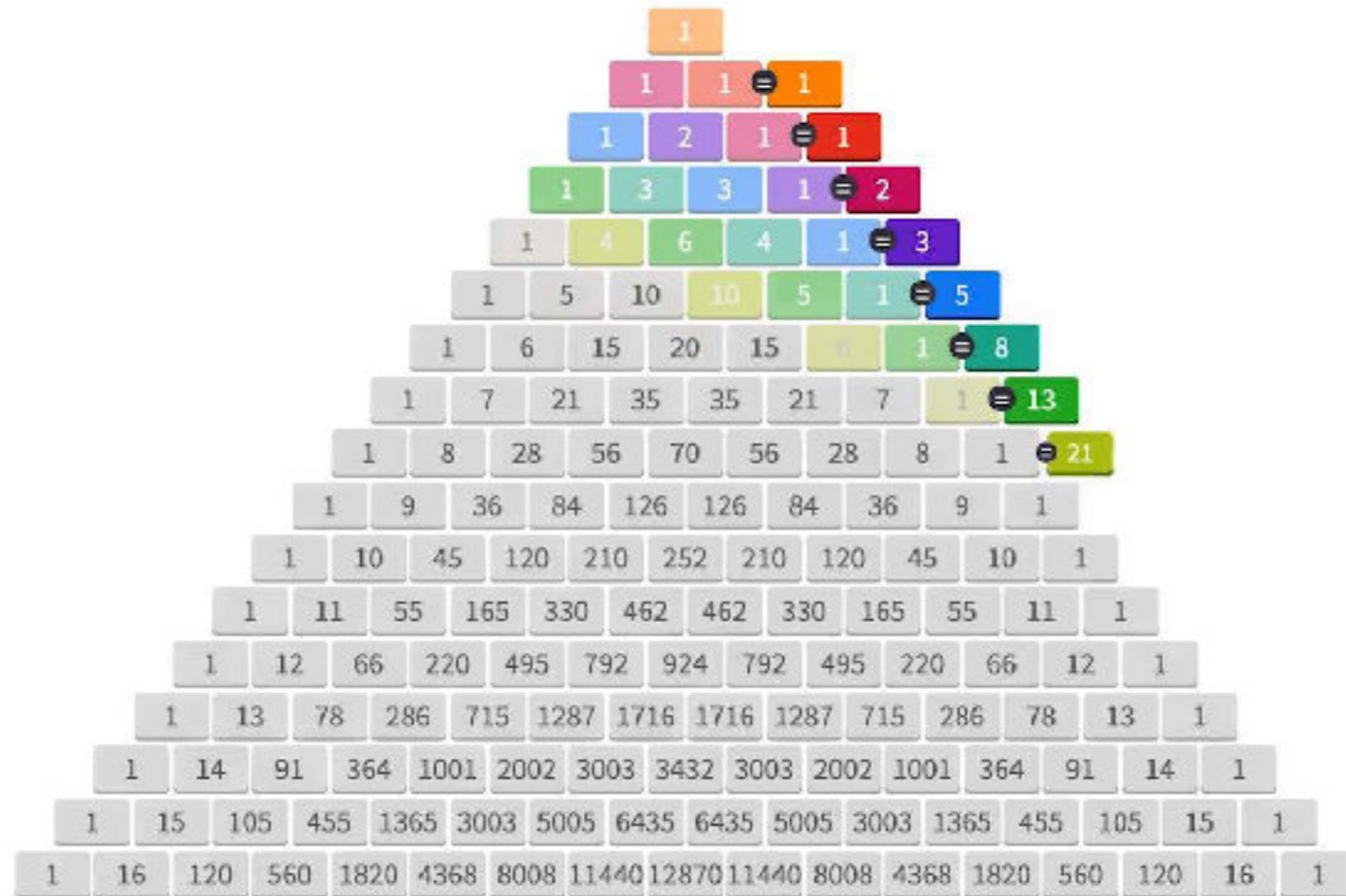
Matt Parker

Mathigon



# Sequences and Patterns

- Trailer
- Introduction
- Arithmetic and Geometric Sequences
- Figurate Numbers
- Sequences as Functions
- Fibonacci Numbers
- Special Sequences
- Pascal's Triangle**
- Limits and Convergence



The diagram above highlights the "shallow" diagonals in different colours. If we add up the numbers in every diagonal, we get the ???.





# Thanks for listening!

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