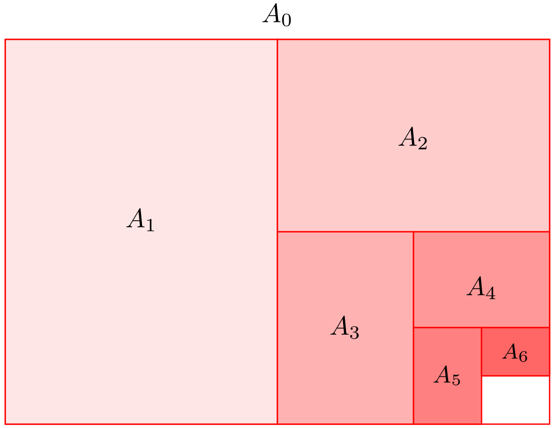


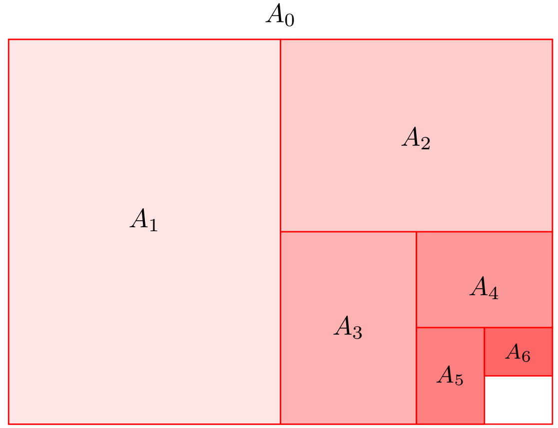
Tasks

1. Watch and listen carefully to the video (*up to 2min 42s*) and explain how the pattern above is constructed and which common property is shared by the different rectangles.

   `https://www.youtube.com/watch?v=AEv7GcJDuew`

2. In the video, the man has started a proof. Work out and explain the end of this proof.
3. Assuming the initial conditions given, that is an A_0-paper has an area of 1 m^2 and that the ratio between its long edge and its short edge is $\sqrt{2}$, prove that there is only one possible length for the long edge of this A_0 rectangle and find out what it is.
4. Work out what the exact dimensions of an A_4-paper should be. Explain to the jury a simple way of checking your result.
5. **Additional question:** some of the ancient Greeks thought that all numbers were rational numbers, that is they could be written as an irreducible ratio of two integers. Try to explain why this is true or not with the number $\sqrt{2}$.

BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014
The A-series of paper – Sujet 1



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BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014
Christmas Chocolates – Sujet 2

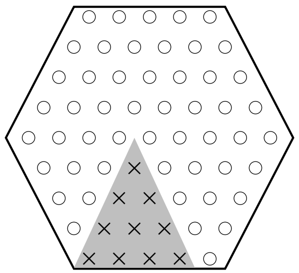
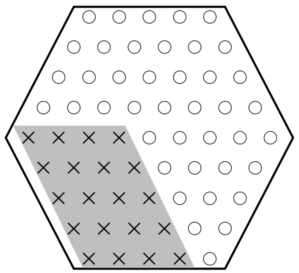
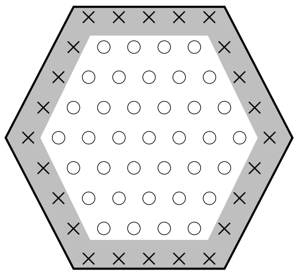
Frango mints are a brand of chocolate truffles. Traditionally flavored with mint and widely popularized, they are now produced and distributed in the US stores.

Historically associated with the Midwestern and Pacific Northwest regions of the United States, the candy is sold in various outlets throughout the country.

One crucial distinction between the two types of Frango chocolates is the packaging. Midwestern Frango chocolates are sold in traditional flat candy boxes, with the chocolates set in candy papers. By contrast, Northwest Frango chocolates are individually wrapped and sold in distinctive hexagon-shaped boxes.

From `https://en.wikipedia.org/wiki/Frango`

William, Kate and Harry were offered each a hexagonal box and ate mint chocolates out of it:

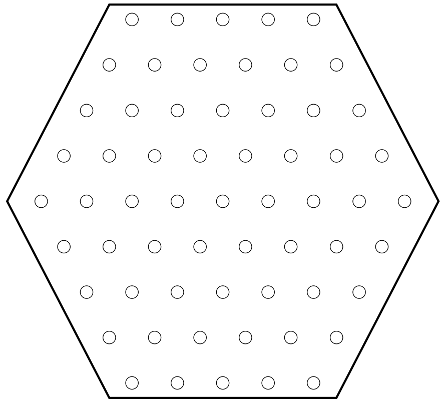
William *I ate 10 chocolates*	**Kate** *I ate 20 chocolates*	**Harry** *I ate 24 chocolates*
		

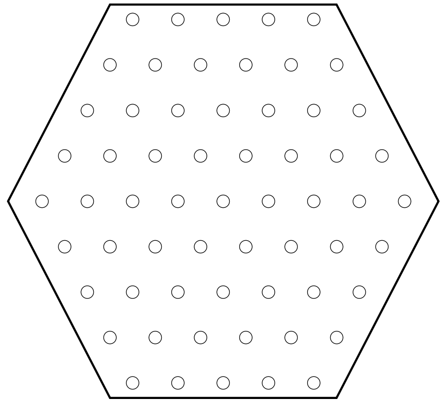
1. Explain how each child managed to work out that there were 61 chocolates in the full box.

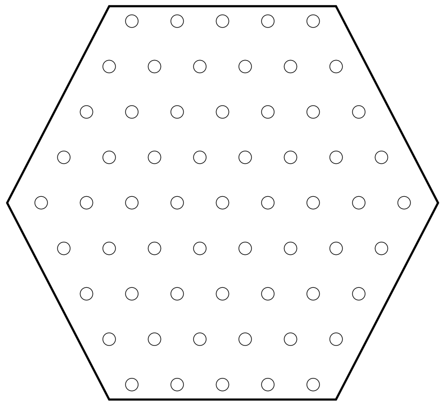
2. William, Kate and Harry have been promised a larger box of chocolates as a Christmas present from their grandmother. The box will have 10 chocolates along each edge, instead of just 5. Explain why the three children won't be able to share the chocolates equally.

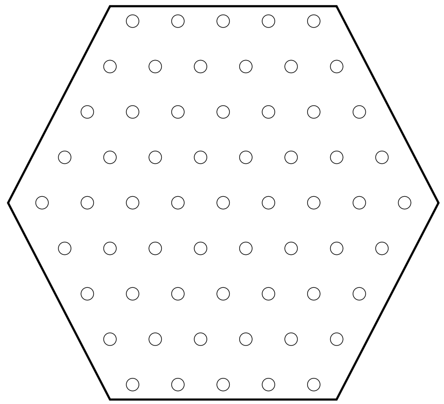
3. You want to find such a hexagonal box for four friends to be able to share the chocolates equally. Explain to the jury if it's possible.

You can use the boxes below to help you









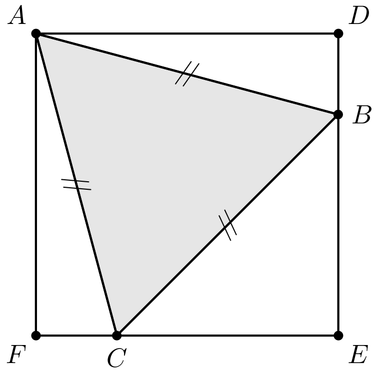
BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014
The inscribed equilateral triangle – Sujet 3

Lilli likes geometry. Her preferred shape is the equilateral triangle. She often plays a geometric game. She draws a figure and tries to find an equilateral triangle inscribed in the figure.

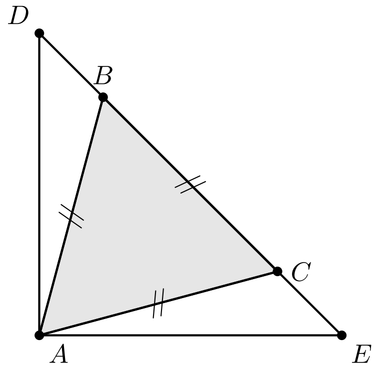
Tasks

Observe the following drawn by Lilli and work out the value (round to the nearest tenth) of the area of each inscribed equilateral triangle. Explain your method to the jury.

Square: $AD = 10\text{cm}$



Isosceles right-angled triangle: $AD = 10\text{cm}$



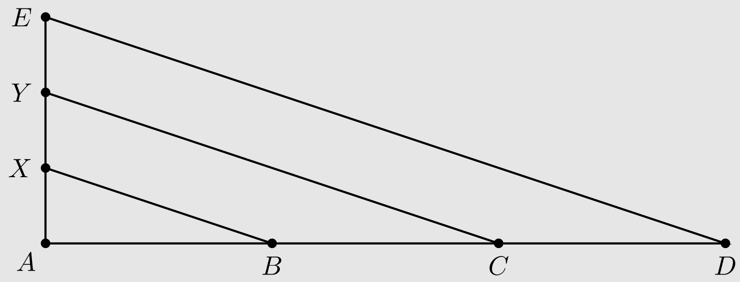
BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014
Numbers constructions – Sujet 4

Document 1 : Constructing square roots

Draw a segment line OA_1 of length 1 from the center of a sheet of paper.
For $n = 1$ to 5
    Draw a direct[a] triangle OA_nA_{n+1} such that $A_nA_{n+1} = 1$ and $\angle A_n = 90°$.
End

[a]direct: named counter-clockwise

Document 2 : Constructing rational numbers



$AB = BC = CD = AE = 1$, lines (BX), (CY) and (DE) are parallel.

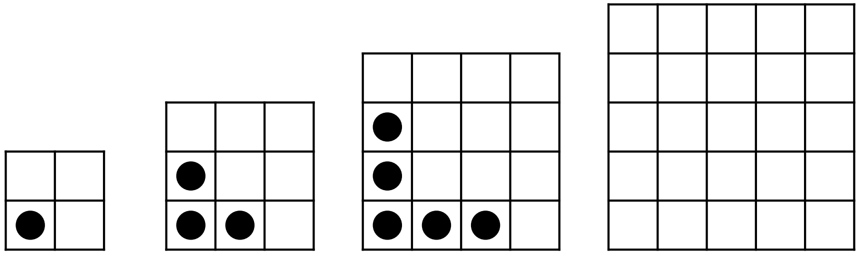
Source: *Richard Bleckmith, Northern Illinois University*

Tasks

1. With Document1 :
   (a) Execute the construction process. Explain what you do.
   (b) Explain why $OA_2 = \sqrt{2}$.
   (c) Imagine two ways of changing the construction process to get $\sqrt{50}$.
2. With Document2 :
   (a) Explain to the jury how to find length AY.
   (b) Describe a way to construct $\frac{2}{7}$ with a ruler and a pair of compasses.
3. Every number used here is constructible with a ruler and a pair of compasses. In your opinion, which number cannot be constructed with those tools?

BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014 – Sujet 5

1. **Study the number of *dotted* tiles in these patterns and answer the following question:**



Complete the 4th pattern above and explain how many dotted tiles you will get in the 20th pattern.

2. **Now study the number of *blank* tiles (tiles without dots) and answer the following questions:**

(a) Complete the table below and describe what you notice:

pattern number	1	2	3	4	5
blank tiles	3	6	11		
first difference	3	5			
second difference					

(b) Explain how you can work out the number of blank tiles in the 20th pattern.

3. **Quadratic sequence**

> **Definition –** *A quadratic sequence is a sequence of numbers in which the first difference between any two consecutive terms is not constant but the second between any two consecutive terms is constant.*
> *In a quadratic sequence, the term of rank n can be written as $T_n = an^2 + bn + c$ where a is half the second difference.*

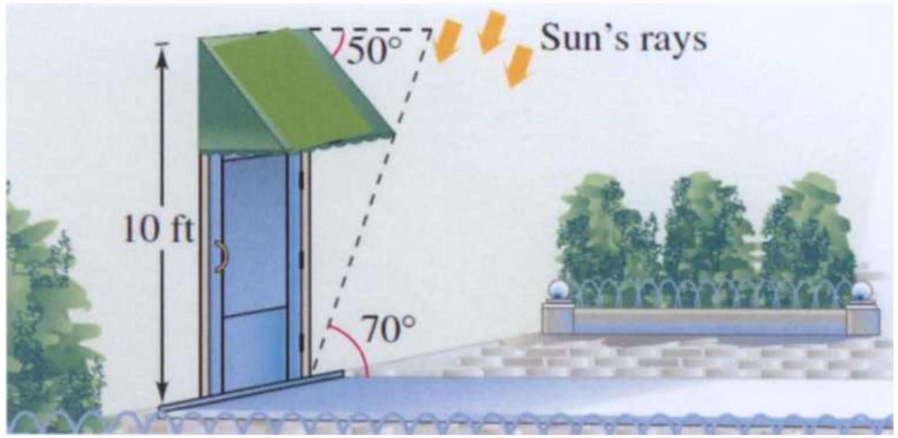
(a) Explain if the number of dotted tiles and the number of blanks tiles are quadratic sequences.

(b) Explain how you can find out the term of rank n of these two sequences.

BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014 – Sujet 6

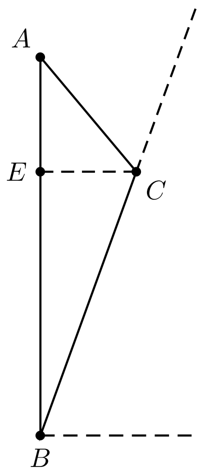
A retractable awning[a] above a door comes at an angle of $50°$ to the horizontal. As shown in the picture, the top of the awning is 10 feet above the ground.
The owner doesn't want any direct sunlight on the door when the angle of the rays of the sun with the ground is geater than $70°$.

[a] awning: *store*



Tasks

1. Explain how the diagram below is related to the problem, and find as many angles as you can.



2. The following "*Law of Sines*" is valid in **any** triangle ABC:

$$\frac{BC}{\sin A} = \frac{AB}{\sin C} = \frac{AC}{\sin B}$$

Explain how you can work out the maximum height of someone entering the house, without having to bend.

3. The owner would like to keep his door in the shade when the sun is lower in the sky.

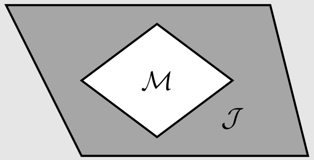
Explain how he would change the drawing and what he could do with the awning.

BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014 – Sujet 7

We usually evaluate probabilities by counting the number of favourable outcomes and dividing that number by the total number of possible outcomes.
Here you will use a related process in which the division involves geometric measures such as length or area. This process is called *geometric probability*.

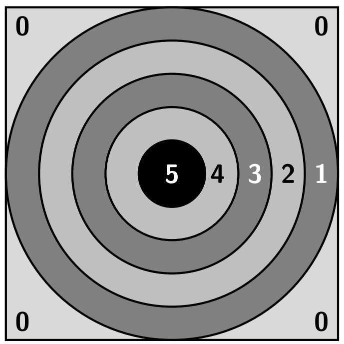
Definition – *Let $\mathcal{J}$ be a region that contains region $\mathcal{M}$. If a point K in $\mathcal{J}$ is chosen at random, then the probability that it is in region $\mathcal{M}$ is as follows:*

$$P\Big(\text{Point } K \text{ is in region } \mathcal{M}\Big) = \frac{\text{Area of } \mathcal{M}}{\text{Area of } \mathcal{J}}$$



Target

Five circles are inscribed in a square target with 10 inch sides. A dart is thrown and hits the target at random.



10 in

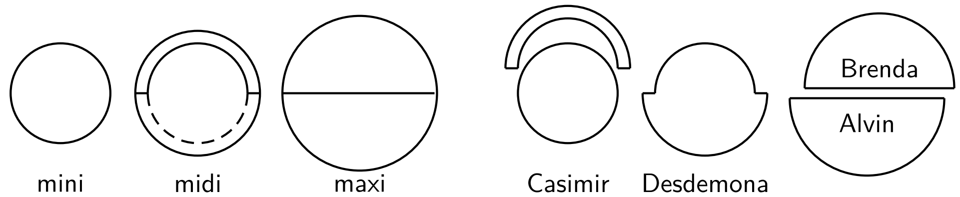
1. Find the probability that the dart hits one of the circles (that is getting a positive score).
2. Find the probability that the dart hits the black region in the centre.
3. Find the probability of getting a score of 0.
4. *(Critical thinking)* Explain your reasoning to show whether the geometric probability model holds true when an expert throws a dart.
5. Explain why, throwing a huge number of darts at random, one can estimate the value of π.

Adapted from
`http://www.nexuslearning.net/books/ml-geometry/Chapter11`
`ML Geometry 11-6 Geometric Probability.pdf`

BACCALAURÉAT - DNL Mathématiques/Anglais - Session 2014 PieThagoras's world famous mince "πs" – Sujet 8

Alvin, Brenda and Casimir went to the pie-shop and bought three of PieThagoras's world-famous perfectly circular mince pies[a]. They bought one mini-pie with diameter 6 cm, one midi-pie with diameter 8 cm and one maxi-pie with diameter 10 cm, because those were the only pies left.
They could have settled for one pie each, but they wanted to share the pies fairly. Now, as everyone knows, PieThagoras's world-famous mince pies consist of two flat layers of pastry, of uniform thickness, with a uniform layer of mince sandwiched in between. The thickness of the pastry and the mince are the same for all sizes of pie. So "*fair*" means "*having equal area* when viewed from above as in my pictures.

[a]Mince pie is a small British fruit-based sweet pie traditionally served during the Christmas season



Place the mini-pie over the middle of the midi-pie, trace round half of its circumference, and join the ends to the edge of the midi-pie.

They decided that sharing the pies fairly would be quite complicated, and had just settled on dividing each pie separately into thirds when Desdemona turned up and demanded her fair share too. Fortunately, they had not started cutting the pies. After some thought, they discovered that now, they could divide the pies more easily, by cutting two of them into two pieces each and leaving the third pie uncut.

From *Professor Stewart's Hoard of mathematical treasures*,
by Ian Stewart *(Profile books)*

1. Explain the problem of "*sharing the pie fairly*" and the title in your own words.
2. Considering the units for the length and the area explain, for the area of a disk with radius r, which is the right formula: $2\pi r$ or πr^2.

   For simplicity, imagine that there are only two people. Explain how they can have the same amount of pie without cutting any of the pies.
3. Now, returning to the initial problem (with four peopole), calculate the area of pie each person should receive.

   Explain the method shown by the pictures and prove that the shares are actually equal.

   Suggest another way to share the pies fairly.