1. **Lost at sea**

You are lost at sea in the fog, just 10 km from the coast (straight). How you can be sure to find the coast by traveling the least km possible.
2. The lifts
In a tower with 10 floors (0, 1, 2, ..., 10), you must develop a 4 lifts management algorithm that minimizes the residents’ latency. Initially we can assume that people arrive randomly in the day to order a lift.
- It goes down or goes up one floor in 3 seconds.
- Each stop at a floor lasts 15 seconds.
3. Gonfler un triangle
ABC est un triangle, on note $d$ la longueur du plus grand côté et G son centre de gravité. On définit le processus gonflage de la manière suivante :

$E_3$ est le triangle ABC. On place le point $M_4$ sur une demi-droite partant de G, le plus loin possible de G et tel que la distance de $M_4$ à chacun des points de $E_3$ soit inférieure ou égale à $d$.

$E_4$ est le polygone convexe contenant $E_3$ et $M_4$.

On fait tourner la demi-droite de 1° et on construit le point $M_5$ sur cette nouvelle demi-droite de la même manière : être le plus loin de G et la distance de $M_5$ à chaque point de $E_4$ soit inférieure ou égale à $d$.

$E_5$ est le polygone convexe contenant $E_4$ et $M_5$.

Ainsi de suite.

Que peut-on dire sur $E_{363}$ ?

3. Blowing up a triangle
ABC is a triangle, d is its longest side and G its center of gravity. We define the inflating process as follows:

$E_3$ is the triangle ABC. Placing the point $M_4$ on a ray starting from G, as far as possible from G such that the distance between $M_4$ and each of the $E_3$ points is less than or equal to d.

$E_4$ is the convex polygon containing $E_3$ and $M_4$.

The ray is rotated by 1° and the point $M_5$ is constructed on this ray in the same way: being the farther from G and distance from $M_5$ to each of $E_4$ points is less than or equal to d.

$E_5$ is the convex polygon containing $E_4$ and $M_5$.

And so on. What can we say about $E_{363}$?

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*Triangle at the beginning*

*First ray with M4*

*Ray rotated by 1° and M5*

*With all the other M points*
4. Let's move the walls!
A "wall" consists of a finite sequence of "stacks", each with a finite number of "bricks". Consider the transformation of removing the first stack, distributing its bricks on the remaining stacks, one brick on the second stack, two in the third, three in the fourth, etc; within the limit of the number of available blocks. If all existing stacks have been reached before exhausting the bricks contained in the first stack, we continue the process by creating new ones.

Example of an initial state (0) with the first two steps (1 and 2)
What can we say about this process (its evolution regarding the initial state)?
5. Distance between words
We have a dictionary in which all words have 5 letters from the alphabet \{A, B, C, D, E, F, G, H\}. For example: ABCAB or BDEFG
We ask you to define a distance between two words in this dictionary. A distance is an application which associates to any word a positive real number and satisfies:
- For X and Y in the dictionary, \(d(X, Y) = d(Y, X)\)
- For X and Y in the dictionary, \(d(X, Y) = 0 \iff X = Y\)
- For X, Y and Z in the dictionary, \(d(X, Z) \leq d(X, Y) + d(Y, Z)\)
6. Filling containers
Three containers A, B and C have respective capacities of 9, 5 and π liters. Initially A contains 9 liters of water, B and C are empty. We are allowed to pour water from a container X into a container Y in the following two conditions:
1) we do not waste water
2) after the pouring, X is empty or Y is full.
Prove that for any ε>0, it is possible, after a finite number of pourings, to get into one of the containers 1 liter of water with an ε precision.
7. Card trick
We start with a stack of cards ... we only keep (in a 32 or 52 deck) aces, 2, 3, 4, 5, and 6.
1. We mix this set of 24 cards and arrange them on a table so that they form a circle, one of the cards is distinguished as the first and defines a direction of travel in the circle.
2. The "player" mentally selects one of the first 6 cards, then selects a second card by shifting a number of cards corresponding to the value of the first card and a third by shifting a number of cards corresponding to the value of the second card and so on, until (always mentally), he gets back into the 6 first cards.
3. The "wizard" then guesses the arrival card.

If we assume that magic does not exist, then whatever the first chosen card, the arrival card must be the same! Investigate!
8. Set ? Curves
Each side of a regular polygon is divided into \( n \) regular segments.
For each consecutive side, we construct the segments \([S_1S'_n]\), \([S_2S'_{n-1}]\), \([S_3S'_{n-2}]\)...
What can one say of the figure made of these segments?

Regular pentagon with \( n=4 \)

Regular pentagon with \( n=20 \)
9. eco-systems

An eco-system is a set of pairs \{(A_i; \alpha_i), 1 \leq i \leq n\} where \(A_i\) is a point of the plane, \(\alpha_i\) an integer corresponding to the number of round trips between this point and the starting point.

To each starting point \(M\) of the plane, we associate the total travel \(T(M)\) corresponding to the eco-system: 
\[ T(M) = \sum_{i=1}^{n} \alpha_i \times MA_i \]

A solution for eco-system is a point \(S\) such as the function \(T\) is minimum in \(S\).

Solving an eco-system is to find all its solutions.

Try to find results for 2 points and then 3 points eco-systems.
10. Being as far as possible
You are in a rectangular room with your three worst enemies.
Where should you be to be as far away as possible from them three.
The distance from them will be the sum of the distances of each of them to you.