



# XII-th French Physicists Tournament

## 2025 problem list

*There is no uniquely favored understanding of a problem's conditions and it is up to each team to interpret the conditions in a way that is both interesting from a physical perspective and coherent with the problem statement. It is assumed that every phenomenon will be studied with the aim of proposing and validating a model that explains the phenomenon and its dependence on the most relevant parameters. All experiments should comply with local safety regulations and care should be exercised when dealing with dangerous equipment and substances. Whenever an experiment is not possible because of safety concerns or monetary reasons the teams are encouraged to perform an analogue experiment if possible. Teams are solely responsible for any damage or injuries incurred while working (or thinking) on the problems.*

### 1. Rip Fast

Is it possible to tell how fast a sheet of paper has been torn into two pieces by examining its torn edges? Investigate how the edge patterns depend on the tearing dynamics and the kind of paper that is used. What types of paper give the largest and smallest estimation uncertainty in the tearing speed?

### 2. Bouncing Honey

When honey is dripping from a spoon, the trickle can stop flowing, oscillate up and down before flowing again. Explain the phenomenon. Investigate how the oscillations depend on the relevant parameters.

### 3. Oscillating Rings

Take two ferromagnetic rings of different radii and tie them by a string. Connect another string to the larger ring in the same point. Now holding the whole construction by the second string, you can suspend it in the air by a magnet placed above (see linked video). Being held only by these vertical strings, the rings are free to rotate around the vertical axis. Investigate their rotational motion based on the parameters of the system (permeability of the rings, moments of inertia, positions, thickness, etc. ). What happens if you replace the central ring with a disk? [https://drive.google.com/file/d/1hyvaKpPFhtNlJ\\_Grksj\\_DE4sJMujqyFy/view?usp=share\\_link](https://drive.google.com/file/d/1hyvaKpPFhtNlJ_Grksj_DE4sJMujqyFy/view?usp=share_link)

### 4. Traveling Flame

Under certain circumstances a flame can travel along an open canal (see link below). Explain the phenomenon. Investigate its lifetime and speed. Under which circumstances does it display a periodic behavior? Maximize the lifetime of a traveling flame for a given amount of fuel. <https://www.youtube.com/watch?v=SqhXQUzVMlQ>

### 5. Flying Coin

One can make a coin fly from a table into a plate placed on it by blowing on it from a certain angle. Investigate the movement of the coin and how it depends on the relevant parameters. What is the maximum height of the plate's edge such that the coin still lands on/in it? Can you predict the face on which the coin lands based on the relevant parameters? [https://youtu.be/CF0mBmYBJw8?si=0KB2KJMEgkqA1\\_8H](https://youtu.be/CF0mBmYBJw8?si=0KB2KJMEgkqA1_8H)

## 6. An Optimal Candle

Maximize the luminosity of a candle by varying its size and shape for a chosen wick. What shape should it have to ensure that, when the wick has fully burnt out, all the wax has also completely vaporized away?

## 10. Rotating Ring

When a magnetic ring is left at the top of a ferromagnetic rod, several types of motion can be observed. Under which conditions does each type of motion appear? Which types of motion lead to the longest fall time for a given ring radius? <https://www.youtube.com/shorts/U1FNOCading>

## 13. Paper blade

Investigate the conditions for a paper sheet to cut through different materials. What is the strongest material the paper blade can cut through?

## 15. Creeping Salt

When concentrated brine (water and dissolved salt) is allowed to evaporate in a container, the salt precipitates and forms small crystals. But more surprisingly, many crystals form outside the container. The salt crawls away from the walls of the container and may cover the outer walls or climb up a plunging rod. Explain the phenomenon. What is the maximum height that salt crystals can reach on the rod? Maximize the amount of salt that can be extracted on the rod per unit volume of evaporated solution via this method.

**16. PET Bottle Rocket** Build your own rocket using a single PET bottle and add any modifications you like. The working principle of the rocket should be via expulsion, without any combustion or chemical reactions. Investigate what are the limits of the height and the speed of such rockets. <https://www.scienceworld.ca/resource/pop-bottle-rocket-part-i-action-and-reaction/> <https://www.grc.nasa.gov/www/k-12/rocket/BottleRocket/about.htm>

## 17. The Slinky

When one places a slinky at the top of a staircase, it can be pushed to travel in its peculiar motion down the stairs. Investigate how the average slope influences the motion of the slinky. What is the minimal average slope such that the slinky successfully reaches its steady periodic motion? What happens if you replace the stairs with an inclined plane?