French Physicists' Tournament
FPT 2017 problems

Société Française de Physique
COMMISSION JEUNES

1. Too many magnets

How many magnets can be accommodated within a given surface area before the structure collapses and the magnets stick together? (video on FPT website) How does the maximal areal number density of magnets depend on the important parameters?

2. LEGO tower

A LEGO mold, water and gelatin can be used to produce jelly, or 'gummy' LEGO bricks (video on FPT website). It is possible to build towers using these gummy LEGO bricks in the same way as can be achieved with their plastic counterparts. What is the maximum height of gummy LEGO tower that can be built and how does this depend on the concentration of gelatin in the bricks?

3. Popcorn

At a certain temperature, popcorn bursts open, jumps and emits a 'pop' sound. Devise a method to estimate the jump height of the corn kernels based on measurements of the sound of the pop and determine the limits of the precision in your chosen method. Typical parameters for consideration may include the type of corn, initial positioning of corn, heating mechanism, heat, heating rate, kernel coupling, etc.

4. Aurora

Construct an experimental setup to simulate the aurora borealis in the laboratory. You should describe the theory behind its operation and give limits for the minimum possible size of your experimental apparatus.

5. Water trail

A spray of water drops can be generated behind the wheels of a moving car on a wet road. How does the height and length of the spray trail that is formed depend on the speed of the car? What is the mean size of the drops that are formed? Can the drops form a mist that is thick enough to seriously reduce the visibility on a busy highway?

6. Light-driven vehicle

Build a toy car that is powered by an external light source. What is the maximum speed that the car can reach if it starts moving from rest? The light source cannot be moving with the car and is limited to 5 W of power consumption. What are the important parameters that influence the final speed of the car?

7. Walking chain

If you apply a short impulse to a long chain spinning around a horizontal axis, the chain may "walk" on a short distance (video on FPT website). Explain this phenomenon and investigate the key parameters of the distance walked.

8. The thing

Leon Theremin is alleged to have designed a spy device called "the thing". Develop your own version of this device in such a way that you can maximize the ratio of its working distance to its largest linear dimension. The optimization should be made after choosing some working frequency less than 1 GHz and some transmitter power less than 1 W (see «The Thing (listening device) » on Wikipedia).

Take into account the legal restrictions on radio transmitters in France!

9. Flat trees

Some liquids don't flow freely down the walls of a vessel, but form tree-like structure (see picture). Which properties are required for liquids to behave in this way? Explain how these properties affect the shape and characteristic dimensions of the structures that are formed by these liquids.

10. Magnetic fissioning of droplets

When a Neodymium magnet is brought close to a ferrofluid droplet suspended on a superhydrophobic surface, the droplets are observed to fission (video on FPT website). Determine the smallest drop size that can be created in this way. How does the smallest drop size depend upon important parameters (initial droplet composition and volume, magnet and surface properties, the speed and position of the magnet approaching the droplet, etc.)?

Pour toute question, vous pouvez contacter le comité d'organisation du French Physicists' Tournament : fpt@sfpnet.fr.