List of problems for the

8th French Physicists' Tournament

2. Pop-Pop away

The Pop-Pop boat is a small toy powered by a candle. Its engine is very simple, since it is just made of a boiler. Propose a boat design that maximizes the travelled distance using a tealight candle. Estimate the energy efficiency of your boat.

3. Dirty racing

Accelerate balls made from different materials (wood, metal, rubber, etc) to a certain velocity. Then let them roll on a flat and horizontal surface of moist sand. Investigate the distance a ball travels before coming to rest.

6. The finger of death

Under some conditions, a stalagmite of ice known as a brinicle can form underneath the frozen surface of an ocean. Reproduce the phenomenon on a laboratory or home scale, and study the brinicle growth rate and its final size. https://youtu.be/lAupJzH31tc

8. Heavy parachute

Is it possible to build a magnetic parachute to protect a load from impact when landing on a non-magnetic metallic surface? How should it be built in order to minimize the impact damage? What are the limitations of your parachute? https://youtu.be/sENgdSF8ppA?t=80

9. Solar retraction motor

A solar retraction motor works by using the thermal shrinkage and relaxation of polyethylene or other materials. Investigate the maximal rotation speed and maximal power of these types of motors, and explore ways to maximize their efficiency using commonly found materials. How do these quantities scale with size of the motor? https://youtu.be/VQqpnAKf9cM

10. Rolling pasta

When spaghetti is rehydrated on a wet cloth, the noodles gradually acquire a curvature that persists even when they are taken out to dry, and they will start moving with some velocity. Investigate the noodle movement and its shape dynamics. Is the phenomenon present for other common shapes of pasta, such as linguine, bucatini or lasagna? https://youtu.be/NyewlvPgxxg

12. Metallic forest

In the electrolysis of aqueous solutions of metal salts, fractal-like dendrites can begin to grow gradually on the electrodes. How can the dendrite shape and fractal dimension be controlled by choice and variation of the setup parameters?

13. Branching light

When a laser beam passes through a thin film (e.g., soap bubble film), random filaments of light are created by formation an effect known as branch flow. Explain the phenomenon. Can one design a medium to produce specific branching patterns? Can it be extended to other wave phenomena (water waves or sound waves, etc)? https://youtu.be/UNCNp1tBqKY

14. Ice clock

An ice cube inside a mix of vegetable oil and baby oil will remain between the two liquids because of its density. As the ice cube melts and releases trapped bubbles, it goes up and down periodically in an intriguing way. Can this experiment be turned into a clock? What would be its longevity and precision? Optimize the setup parameters (shape, temperature, composition, length scales, etc) to obtain the maximal clock precision. https://youtu.be/rEstw8LLMpY

16. Graphite lamp

Devise the most energy efficient lamp possible using the graphite rod from a pencil. Investigate how the intensity and duration of the light depend on the hardness of the graphite and other relevant parameters.

17. Quantum-droplet analogy

Small droplets on the surface of a liquid can exhibit quantum-like behavior in analogy with the so-called pilot wave theory. Construct an experiment to test as many quantum analogies as possible, and discuss the theoretical and experimental limitations of this analogy. Can the analogy be pushed to cover phenomena involving entanglement, such as Bell inequality violations? https://youtu.be/WIyTZDHuarQ