

1. Ink tree

When a drop of ink is injected inside especially still water, or dropped very close to its surface, it firstly forms a ring of ink which then divides into smaller rings ([video on FPT website](#)). The process repeats again and again and forms a tree-like structure of ink. What is the maximal number of ring divisions that one can see and how does it depend on the important parameters?



2. Erratic raindrops

When a car moves with high speed in rain sometimes the drops on its side window walk up but not down. Explain the phenomenon and find the conditions for it to occur (size of the drops and the car speed for example). What determines the drop trajectory and how does it depend on the important parameters? *Only lab experiments are expected!*

3. Fluidic Calculator

Droplets having different concentrations of food coloring (containing propylene glycol) move in beautiful and intricate patterns when placed on a clear glass slide ([video on FPT website](#)). A wide variety of autonomous fluidic machines can be produced using this property. Implement diverse arithmetic operations using such droplets and optimize the operation speed.



4. Bubble light

Sonoluminescence is the emission of short bursts of light from imploding bubbles in liquid. Although the effect has been known for decades, there is no widely-accepted explanation. Suggest a setup to observe the phenomenon and to study the spectrum of emitted light. Can this effect be used to obtain coherent laser-like light emission?

5. Candle lighting trick

It is possible to relight a candle that has just been blown out by lighting the smoke that is created in the process ([video on FPT website](#)). Indeed, the smoke contains vaporized wax which is the substance that burns in the flame in the first place. What is the maximum distance (between the match and the candle) from which one can relight the candle? Identify the important parameters and find how they influence this maximal distance.



6. Screaming balloon

If you put a hex nut in a balloon it is possible to make it «scream» by giving a certain rotational movement to the balloon ([video on FPT website](#)). How do the characteristics of the sound produced depend on the important parameters of the system?



7. Static speaker

Build an audio speaker without any moving part. Discuss the maximum bandwidth, signal-to-noise ratio and power efficiency achieved with your design. Is it possible to modify your device to use it as a microphone?

8. Quaint jet

When water is forced through a thin slit, the flow sometimes takes the shape of a helix. Describe the phenomenon and explain the dependence of the aspect ratio(s) of the helix on the fluid parameters, parameters of the flow and the shape of the nozzle.

9. Half-life sparkles

Sparks caused by an angle grinder tend to fly over a certain distance and then to split into several smaller sparks. What causes them to split? What is the condition for a split to occur? What influences the distance before the split? What will be the distance distribution of the sparks to fly?

Be extremely careful when performing experiments!



10. Particle detectors for dummies

Build a simple device that can detect cosmic ray particles. Characterize the particle identification capabilities of your device. Try to test your device in different conditions and also try to obtain the energy spectrum of the cosmic ray particles.

11. Balancing pebble

Stones which are taken by wind on the ice of Baikal Lake can be found after some time staying on a thin «stand». Reproduce and explain this «stand» phenomenon and estimate the curve of the stand depending on the important parameters.



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