



List of problems for the 9th French Physicists' Tournament

4. Filled ball

A ping-pong ball that has been partially filled with some fluid or sand will bounce much lower than a filled one. Explain this phenomenon. How does the height of the bounce depend on the relevant parameters? [youtube]

6. Flat Earth

Propose an experiment using only a camera and/or the sensors of your smartphone to prove or disprove the flat Earth hypothesis. Using the same equipment, estimate the size of the Earth with as high accuracy as possible.

7. Washboard roads

When an unpaved road (usually sand or gravel) is used by many cars, a wavy pattern is formed causing strong discomfort for the drivers. Study how the wave parameters depend on the properties of the granular material and on the average speed of the cars. Is there a safe way to drive fast on this type of road? [article]

8. Ferrofluidic patterns

When ferrofluid is placed in a rotating magnetic field, strange patterns may appear. Investigate the shape of these patterns and characterize them in terms of the relevant parameters. [youtube]

9. Electrostatic lighter

Ancient people used to make fire by rubbing wood. Propose an alternative setup, based on electrostatic effects, made from materials available to Bronze age people. Make a device capable of setting fire using just static electricity in the shortest time possible to a piece of wood.

10. Droplet sandy fingerprints

When droplets fall on a surface covered by a layer of sand, interesting patterns are formed. Study the formation process. What parameters of the droplets can be inferred from the resulting crater?



11. Smashing spheres

Smashing two steel spheres together with a paper in between at the point of collision, produces enough heat that it burns off the paper. Conducting the same experiment with aluminium foil, you will observe concentric rings on the foil after collision. Study this phenomenon. Can it be observed for other materials? [youtube]

12. Inverse coffee cup vibration problem

If you tap the top of a coffee cup with a spoon you will notice that the sound strongly depends on where you tap. Knowing the cup geometry one can predict the frequency spectrum of the emitted sound when tapping at different points. Consider now the inverse problem and find an experimental technique to reconstruct the cup geometry from the emitted sound. What is the minimal knowledge about the cup geometry needed to make the problem solvable? [youtube]

13. Chaotic magnetic pendulum

Consider a pendulum consisting of a magnetic bob attached to a string. If the pendulum is allowed to swing over a structure of permanent magnets, it will display complex motion. Study the pendulum dynamics and its dependence on the number of permanent magnets and their arrangement. [youtube]

14. Rising in the bulk

If a vessel containing granular material is shaken appropriately, an item placed at the bottom will ascend upward through the material and emerge at the top. Explain the phenomenon and devise the most energy efficient shaking technique to raise the item up. [youtube]

15. Galileo method

What is the maximum height a piece of chalk might be dropped without breaking for a given surface? Which parameters does the height depend on? Are there any dropping or throwing techniques which minimize the breakage probability?