

Problems for the 31st IYPT 2018

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The originator of a new concept finds, as a rule, that it is much more difficult to find out why other people do not understand him, than it was to discover the new truth.

Hermann von Helmholtz

1. Invent Yourself

Construct a simple seismograph that amplifies a local disturbance by mechanical, optical or electrical methods. Determine the typical response curve of your device and investigate the parameters of the damping constant. What is the maximum amplification that you can achieve?

2. Colour of Powders

If a coloured material is ground to a powder, in some cases the resulting powder may have a different colour to that of the original material. Investigate how the degree of grinding affects the apparent colour of the powder.

3. Dancing Coin

Take a strongly cooled bottle and put a coin on its neck. Over time you will hear a noise and see movements of the coin. Explain this phenomenon and investigate how the relevant parameters affect the dance.

4. Heron's Fountain

Construct a Heron's fountain and explain how it works. Investigate how the relevant parameters affect the height of the water jet.

5. Drinking Straw

When a drinking straw is placed in a glass of carbonated drink, it can rise up, sometimes toppling over the edge of the glass. Investigate and explain the motion of the straw and determine the conditions under which the straw will topple.

6. Ring Oiler

An oiled horizontal cylindrical shaft rotates around its axis at constant speed. Make a ring from a cardboard disc with the inner diameter roughly twice the diameter of the shaft and put the ring on the shaft. Depending on the tilt of the ring, it can travel along the shaft in either direction. Investigate the phenomenon.

7. Conical Piles

Non-adhesive granular materials can be poured such that they form a cone-like pile. Investigate the parameters that affect the formation of the cone and the angle it makes with the ground.

8. Cusps in a Cylinder

A horizontal cylinder is partially filled with a viscous fluid. When the cylinder is rotated around its axis, unusual fluid behaviour can be observed, such as cusp-like shapes on the walls of the cylinder. Investigate the phenomenon.

9. Candle in Water

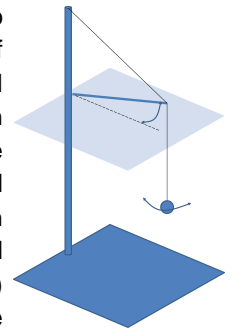
Add some weight to a candle such that it barely floats in water. As the candle burns, it may continue to float. Investigate and explain this phenomenon.

10. Tesla Valve

A Tesla valve is a fixed-geometry, passive, one-direction valve. A Tesla valve offers a resistance to flow that is much greater in one direction compared to the other. Create such a Tesla valve and investigate its relevant parameters.

11. Azimuthal-Radial Pendulum

Fix one end of a horizontal elastic rod to a rigid stand. Support the other end of the rod with a taut string to avoid vertical deflection and suspend a bob from it on another string (see figure). In the resulting pendulum the radial oscillations (parallel to the rod) can spontaneously convert into azimuthal oscillations (perpendicular to the rod) and vice versa. Investigate the phenomenon.



12. Curie Point Engine

Make a nickel disc that can rotate freely around its axis. Place a magnet near the edge of the disc and heat this side of it. The disc starts to rotate. Investigate the parameters affecting the rotation and optimize the design for a steady motion.

13. Weighing Time

It is commonly known that an hourglass changes its weight (as measured by a scale) while flowing. Investigate this phenomenon.

14. Radiant Lantern

When taking a picture of a glowing lantern at night, a number of rays emanating from the centre of the lantern may appear in the pictures. Explain and investigate this phenomenon.

15. Blowing Bubbles

When blowing on a soap film in a ring, a bubble may be formed. The liquid film may pop or continue to exist. Investigate how the number of bubbles produced from a single soap film and the characteristics of the bubbles depend on the relevant parameters.

16. Acoustic Levitation

Small objects can levitate in acoustic standing waves. Investigate the phenomenon. To what extent can you manipulate the objects?

17. Water Bottle

The current craze of water bottle flipping involves launching a partially filled plastic bottle into the air so that it performs a somersault before landing on a horizontal surface in a stable, upright position. Investigate the phenomenon and determine the parameters that will result in a successful flip.

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Figure by Andrei Klishin; **Problem selection committee:** John Balcombe, Samuel Byland, Ilya Martchenko; **Epigraph** selected by Evgeny Yunosov

2018年第31届国际青年物理学家竞赛(IYPT)题目(仅供参考)

- 1. 发明创造** 建造一台能放大由力、光或电所引起的局部干扰的测震仪。确定你建造的设备的典型响应曲线,并研究影响阻尼系数的相关因素。你的仪器能达到的最大放大率是多少?
- 2. 粉末的颜色** 如果染过色的材料被磨成粉末,有的时候最终得到的粉末可能会和原来的材料有着不同的颜色。研究材料的碾磨程度是如何影响粉末的表面颜色的。
- 3. 硬币跳舞** 准备一个冷却充分的瓶子,把一枚硬币放在它的瓶口上。过一段时间你会听见声响并看到硬币在移动。解释这个现象并研究相关因素是如何影响这舞蹈的。
- 4. 海伦喷泉** 建造一座海伦喷泉并解释它是如何工作的。研究相关因素是如何影响水柱的高度的。
- 5. 吸管** 当一根吸管放在一杯碳酸饮料里的时候,它可以浮起来,有时倒在玻璃杯的边缘。研究并解释吸管的运动,并判断在何种条件下,吸管会倒下。
- 6. 环形加油器** 一根涂了油的水平圆柱轴能绕着它的轴以恒速旋转。用硬纸板盘做一个内径大概为轴直径两倍的环,并把它放在轴上。根据倾斜程度,它可以沿着轴向两个方向运动。研究这个现象。
- 7. 锥形堆** 倒下一些不具有黏性的颗粒材料,使它们能形成一个锥型的堆。研究影响锥的形成和锥与地面形成的角度的相关因素。
- 8. 筒中尖** 一个水平圆柱筒被一种黏性流体部分充满。当圆筒绕着它的轴旋转时,可以观察到不寻常的流体现象,如筒内壁上的尖锐形状。研究该现象。
- 9. 水中蜡烛** 给一根蜡烛加点重量,使其勉强能浮在水面上。随着蜡烛燃烧,它可能会继续漂浮。研究并解释这一现象。
- 10. 特斯拉阀** 特斯拉阀是一种几何形状固定的被动单向阀。特斯拉阀对单方向流动的阻碍要比对另一方向的阻碍大得多。制造这样一个特斯拉阀,并研究它的相关参数。
- 11. 方位角-径向摆** 将一根弹性棒的一端水平固定在硬支架上。用一根绷紧的绳吊起棒的另一端以避免竖直方向的偏差,并用另一根绳在上面悬挂一个摆锤。得到的摆的径向振动(与棒平行)能自发地转变成有方位角的振动(与棒垂直),反之亦然。研究这个现象。
- 12. 居里点引擎** 制作一个可以围绕它的轴心自由旋转的镍盘。在靠近镍盘边缘的地方放置一块磁铁并对这一侧进行加热。镍盘开始旋转。研究影响镍盘转动的因素,并优化你的设计,使之稳定旋转。
- 13. 称量时间** 众所周知,沙漏在流沙时,它(用秤称出来的)重量会发生变化。研究这个现象。
- 14. 灯光四射** 晚上拍摄发光的灯笼,照片上可能会出现一些从灯笼中心放射出来的光线。解释并研究这一现象。
- 15. 吹泡泡** 向圆环中的皂液薄膜吹气,可能会吹出一个泡泡。液膜可能会破,也可能继续存在。研究相关因素怎样决定一张皂液薄膜产生的泡泡的数量,以及泡泡的特性。
- 16. 声悬浮** 小物件可以在竖直的声波中悬浮。研究这个现象。你对小物件的操纵能达到什么程度?
- 17. 水瓶** 近来十分流行的翻水瓶中有一个动作,将部分充满的塑料瓶扔到空中,让它翻个跟头,然后稳稳地直立落在水平面上。研究这个现象,确定动作成功的影响因素。