中国大学生物理学术竞赛2017年题目

1. Invent Yourself

Construct a passive device that will provide safe landing for an uncooked hen’s egg when dropped onto a hard surface from a fixed height of 2.5 m. The device must fall together with the egg. What is the smallest size of the device you can achieve?

发明创造

请设计和制造一个装置，能保护一个鸡蛋从2.5m的高度自由落下到硬地面上并且这个装置必须和鸡蛋同时下落，你能够设计的最小尺寸是多少？

2. Balloon Airhorn

A simple airhorn can be constructed by stretching a balloon over the opening of a small container or cup with a tube through the other end (see Figure). Blowing through a small hole in the side of the container can produce a sound. Investigate how relevant parameters affect the sound.

气球汽笛

一个简单的汽笛可以这样制造：用一根穿过一只小型容器（或杯子）底部的管子拉伸位于容器（或杯子）开口处的气膜。经过在容器侧壁处的小孔，鼓风可以产生一个声音。解释声音受到相关参量的影响。

3. Single Lens Telescope

A telescope can be built using a single lens, provided that a small aperture is used instead of an eyepiece. How do the parameters of the lens and the hole influence the image (e.g. magnification, sharpness and brightness)?

单透镜望远镜

一架望远镜可只用一枚透镜制作，如果小光圈被用于替代目镜，那么透镜参数和小孔将会怎样影响所成的图像（如放大率、清晰度和亮度）？

4. Magnetic Hills

A small amount of a ferrofluid placed in an inhomogeneous magnetic field forms hill-like structures. Investigate how the properties of these structures depend on relevant parameters.

磁场山

置于非均匀磁场中的少量磁性流体会形成山丘状结构，讨论这些结构的属性如何依赖于相关参数。

5. Leidenfrost Stars

In the Leidenfrost effect, a water drop placed on a hot surface can survive for minutes. Under certain circumstances, such a drop develops oscillating star shapes. Induce different oscillatory modes and investigate them.

莱氏星星

在莱氏效应中，置于热表面的水滴可存在几分钟。在某些情况下，水滴会发展为振荡的星形状态。引入不同的振荡模式并探讨它们。

6. Fast Chain

A chain consisting of wooden blocks inclined relative to the vertical and connected by two threads (see Figure) is suspended vertically and then released. Compared to free fall, the chainfalls faster when it is dropped onto a horizontal surface. Explain this phenomenon and investigate how the relevant parameters affect the motion.

快链条

一根链条由若干相比于水平有一定角度的木棍组成，且由两根线连接，垂直悬挂然后释放。相比于自由落体，当掉至水平地面时，链条掉落更快。解释此现象并研究相关参量如何影响链条的运动。

7. Spiral Waves

Spiral waves and other types of wave patterns may occur on a thin liquid film flowing over a rotating disk. Investigate these wave patterns.

螺旋水波

当薄层液膜流过一个旋转的平台可能会出现螺旋波或者其他波，探讨这些波的类型。

8. Visualising Density Schlieren Photography is often used to visualise density variations in a gas. Build a Schlieren setup and investigate how well it can resolve density differences.

密度可视化

纹影摄影术通常用于使气体中的密度变化可视化。安装一套纹影装备并且研究在这种方法在解决密度差异的优势。

9. Ball in a Tube

A sealed transparent tube is filled with a liquid and contains a small ball. The tube is inclined and its lower end is attached to a motor such that the tube traces a conical surface. Investigate the motion of the ball as a function of relevant parameters.

管中球

现有一根充满液体并含有一枚小球的密封透明管，此管倾斜放置且下端与马达相连，如此管沿锥形面运动。探讨球在相关参数作用下的运动。

10. Pulling Glasse

Apart Put a thin layer of water between two sheets of glass and try to separate them. Investigate the parameters affecting the required force.

把玻璃拉开

在两片薄玻璃之间放置一层薄薄的水，然后试着把它们分开。研究相关参数对临界力的影响。

11. Hair Hygrometer

A simple hygrometer can be built using human hair. Investigate its accuracy and response time as a function of relevant parameters.

头发湿度计

一只简单的湿度计可仅用人的毛发制作。研究这个装置的精确度和响应时间作为相关参量的函数。

12. Torsion Gyroscope

Fasten the axis of a wheel to a vertical thread that has a certain torsional resistance (see Figure). Twist the thread, spin the wheel, and release it. Investigate the dynamics of this system.

扭转陀螺

将轮轴固定于具有一定扭转阻力的竖直线上，扭转绳子，旋转轮子并释放它，研究此系统的动力。

13. Resonating Glass

A wine glass partially filled with liquid will resonate when exposed to the sound from a loudspeaker. Investigate how the phenomenon depends on various parameters.

玻璃共振

一个装满液体的酒杯，在扬声器的作用下将会发生共振，研究这个现象是如何依赖于相关参量。

14. Gee-Haw Whammy

Diddle A gee-haw whammy diddle is a mechanical toy consisting of a simple wooden stick and a second stick that is made up of a series of notches with a propeller at its end. When the wooden stick is pulled over the notches, the propeller starts to rotate. Explain this phenomenon and investigate the relevant parameters.

念力转机

念力转机是一只机械玩具，由一根简单的木棍和第二根有一系列刻痕和棍尾处有螺旋桨的木棍组成的。当木棍拉到缺口，螺旋桨开始旋转。解释此现象并探讨相关参数。

15. Boiled Egg

Suggest non-invasive methods to detect the degree to which a hen’s egg is cooked by boiling. Investigate the sensitivity of your methods.

煮蛋

设计一个方案，在不破坏煮过的鸡蛋情况下，判断这个鸡蛋有几分熟。分析这个方案的准确度。

16. Metronome Synchronization

A number of mechanical metronomes standing next to each other and set at random initial phases under certain conditions reach synchronous behaviour in a matter of minutes. Investigate the phenomenon.

"同步"节拍器

几个节拍器摆在一起，他们从随机不同的初相位同时释放，满足一定条件之后，他们就会在几分钟之内达到同步。研究这个现象。

17. Vacuum Bazooka

A ‘vacuum bazooka’ can be built with a simple plastic pipe, a light projectile, and a vacuum cleaner. Build such a device and maximise the muzzle velocity.

真空火箭筒

用塑料管，吸尘器，再加上一个轻物体，就能做一个"火箭筒"了。请制作一个这样的火箭筒，并且把他的出射速度达到最大化。