

北京师范大学珠海校区 2023 年物理学术竞赛题目

_____题目以英文原文为准

1. Invent Yourself

Take a box (e.g. a matchbox), filled with identical objects (e.g. matches, balls, ...). Find a method to determine the number of objects in the box solely by the sound produced while shaking the box. How does the accuracy depend on the properties of the objects, the box, and the packing density?

第一题：自己发明

拿一个里面装满了相同东西(例如火柴、球.....)的盒子(例如火柴盒)。找到一种方法：仅通过摇晃盒子时产生的声音来确定盒子中物体的数量。请研究盒内物体、盒子和包装密度的属性是如何影响这种方法精确度的？

2. Droplet Microscope

By looking through a single water droplet placed on a glass surface, one can observe that the droplet acts as an imaging system. Investigate the magnification and resolution of such a lens.

第二题：液滴显微镜

通过观察放置在玻璃表面上的单个水滴，我们可以观察到水滴就像一个成像系统。请研究这种透镜的放大倍率和分辨率。

3. Rigid Ramp Walker

Construct a rigid ramp walker with four legs (e.g. in the form of a ladder). The construction may begin to 'walk' down a rough ramp. Investigate how the geometry of the walker and relevant parameters affect its terminal velocity of walking.

第三题：刚性坡道行走器

建造一个四条腿的刚性坡道行走器(例如梯子样式)，该行走器可以沿着粗糙的斜坡往下“行走”。研究行走器的几何结构和相关参数如何影响其行走终端速度的。

4. Charge Meter

A lightweight ball is suspended from a thread in the area between two charged plates. If the ball is also charged it will be deflected to one side at a certain angle. What is the accuracy of such a device for measuring the amount of charge on the ball? Optimise your device to measure the smallest possible charge on the ball.

第四题：电荷测量计

一个轻球被一根线悬挂在两个带电极板之间的区域。如果球也带电，它会以一定的角度偏转到一边。这种测量球上电荷量的装置的精度是多少？优化你的装置来测量球上尽可能小的电荷。

5.Ping Pong Rocket

A ping pong ball is placed in a container of water. When the container is dropped, the ping pong ball will get launched to a great height. What maximum height can you reach with up to 2 liters of water?

第五题：乒乓球火箭

一个乒乓球被放在一个盛水的容器里。当容器掉落时，乒乓球会被弹射到很高的地方。用最多 2L 水，你能弹射到的最大高度是多少？

6.Non-contact Resistance

The responses of a LRC circuit driven by an AC source can be changed by inserting either a non-magnetic metal rod or a ferromagnetic rod into the inductor coil. How can we obtain the magnetic and electric properties of the inserted rod from the circuit's responses?

第六题：非接触式电阻

通过在电感线圈中插入非磁性金属棒或铁磁性棒，可以改变由交流源驱动的 LRC 电路的响应。我们如何从电路的响应中获得插入棒的磁性和电学性质？

7.Giant Sounding Plate

When a large, thin and flexible plate (e.g. plastic, metal or plexiglass) is bent, it may produce a loud and unusual howling sound. Explain and investigate this phenomenon.

第七题：巨型发声板

当一个又大又薄又柔韧的板被弯曲时（例如塑料、金属或有机玻璃等），它可能会发出一种响亮而不寻常的呼啸声。解释并研究这一现象。

8.Another Magnetic Levitation

Place a large disk-shaped magnet on a non-magnetic conductive plate. When a smaller magnet is moved under the plate, the magnet on top may levitate under certain conditions. Investigate the levitation and the possible motion of the magnet on top.

第八题：另一类磁悬浮

将一个大的圆盘形磁铁放在非磁性导电板上。当一个较小的磁铁在板下移动时，在一定条件下，上面的磁铁可能会悬浮起来。研究顶部磁铁的悬浮现象及其可能的运动。

9.Juicy Solar Cell

A functional solar cell can be created using conducting glass slides, iodine, juice (eg. blackberry) and titanium dioxide. This type of cell

is called a Grätzel cell. Make such a cell and investigate the necessary parameters to obtain maximum efficiency

第九题：果汁太阳能电池

一个功能性的太阳能电池可以用导电玻璃片、碘、果汁（例如黑莓汁）和二氧化钛制作。这种类型的电池称为 Grätzel 电池。制作这样一个电池并研究获得最大效率所需的参数。

10.Magnetic Gear

Take several identical fidget spinners and attach neodymium magnets to their ends. If you place them side by side on a plane and rotate one of them, the remaining ones start to rotate only due to the magnetic field. Investigate and explain the phenomenon.

第十题：磁力齿轮

取几个相同的指尖陀螺，并将钕磁铁固定在它们的末端。如果把它们并排放在一个平面上并旋转其中一个，剩余的陀螺就会因为磁场而开始旋转。研究并解释这一现象。

11.Pumping Straw

A simple water pump can be made using a straw shaped into a triangle and cut open at the vertices. When such a triangle is partially immersed in water with one of its vertices and rotated around its vertical axis, water may flow up through the straw. Investigate how the geometry and other relevant parameters affect the pumping speed.

第十一题：吸管水泵

可以将一根吸管折成三角形并在顶点处切开来制作一个简单的水泵。当这样一个三角形的一个顶点部分浸入水中并绕其垂直轴旋转时，水可能会通过吸管向上流动。研究几何形状和其他相关参数如何影响抽速。

12.The Soap Spiral

Lower a compressed slinky into a soap solution, pull it out and straighten it. A soap film is formed between the turns of the slinky. If you break the integrity of the film, the front of the film will begin to move. Explain this phenomenon and investigate the movement of the front of the soap film.

第十二题：肥皂螺旋

将一个压缩的玩具弹簧放入肥皂溶液中，把它拉出并拉直，会在弹簧的转弯处形成肥皂膜。如果破坏了膜的完整性，肥皂膜的前部就会开始移动。解释这一现象并研究肥皂膜前部的运动。

13.Shooting Rubber Band

A rubber band may fly a longer distance if it is non-uniformly stretched when shot, giving it spin. Optimise the distance that a rubber band with spin can reach.

第十三题：射击橡皮筋

如果橡皮筋在发射时被不均匀拉伸而使其旋转，它可能会飞行更远的距离，优化带旋转的橡皮筋发射所能到达的距离。

14.Ruler Trick

Place a ruler on the edge of a table, and throw a ball at its free end.The ruler will fall. However, if you cover a part of the ruler with a piece of paper and repeat the throw, then the ruler will remain on the table while the ball will bounce off it. Explain this phenomenon, and investigate the relevant parameters.

第十四题：尺子戏法

将一把尺子的一端放在桌子边缘，然后将一个球投向尺子的另一端，尺子将会落下。然而，如果你用一张纸盖住桌子上的尺子并重新投掷小球，那么尺子将保留在桌子上，而球会从尺子上弹开。解释这一现象，并研究相关参数。

15.Wet Scroll

Gently place a piece of tracing paper on the surface of water. It rapidly curls into a scroll and then slowly uncurls. Explain and investigate this phenomenon.

第十五题：湿纸卷

把一张描图纸轻轻地放在水面上，它会迅速卷曲成一个筒，然后慢慢展开。解释并研究这一现象。

16.Cushion Catapult

Place an object on a large air cushion and drop several other objects in such a way that the first object is catapulted away.Investigate how the exit velocity depends on relevant parameters.

第十六题：气垫弹射器

将一个物体放在一个大的气垫上，然后以同样的方式把其他几个物体扔下去，这样第一个物体就会弹射出去。研究弹射速度与相关参数的关系

17.Quantum Light Dimmer

If you put a flame with table salt added in front of a vapour sodium lamp, the flame casts a shadow. The shadow can become lighter,if the flame is put into a strong magnetic field. Investigate and explain the phenomenon.

第十七题：量子调光器

如果你把加了食盐的火焰放在蒸汽钠灯前，火焰会投射出阴影。如果把火焰被置于强磁场中，这个阴影会变得更轻。研究并解释这一现象。