

Problems for the 37th IYPT 2024

Released by the IOC on 25 July 2023

I hope we'll be able to solve these problems before we leave. – Pál Erdős

A DOKUMENTUMOT DIGITÁLIS
ALÁÍRÁSSAL LÁTTA EL:



AVDH SIGN

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?

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.

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.

4. 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.

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?

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?

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.

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.

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.

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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.

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.

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.

13. 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.

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.

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.

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.

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.

Problem Selection Committee: John Balcombe, Ryan Hsiao-Tzu Lin, Sam Edgecombe and Samuel Byland

IYPT 题目

1. 自研创新

拿一个盒子（例如火柴盒），里面装有相同的東西（例如火柴、球等）。找到一种方法，只需通过摇动盒子时产生的声音，就可以确定盒子中有多少个东西。这个方法的准确性是如何依赖于物体的属性、盒子以及包装密度的？

2. 液滴显微镜

通过观察放在玻璃表面上的一个水滴，我们可以发现液滴起到了成像系统的作用。研究这种透镜的放大倍数和分辨率。

3. 刚性斜坡步行装置

构建一个由四条腿组成的刚性斜坡步行装置（例如梯子形状）。构造物可能会沿着一个粗糙的斜坡向下“行走”。研究步行装置的几何形状和相关参数是如何影响其行走的终端速度的。

4. 射击橡胶带

如果橡胶带在射击时不是均匀拉伸的，它可能会飞得更远，并产生旋转。优化具有旋转的橡胶带可以达到的最大距离。

5. 乒乓火箭

把一个乒乓球放在一容器水中。当容器跌落时，乒乓球将会被发射到很高的高度。使用最多 2 升的水，可以达到的最大高度是多少？

6. 非接触电阻

当一个 LRC 电路由交流电源驱动时，将非磁性金属棒或磁性棒插入到电感线圈中可以改变电路的响应。我们如何从电路的响应中获得插入棒的磁性和电属性？

7. 巨大的声音板

当一个大的、薄的、柔性的板材（例如塑料、金属或有机玻璃）被弯曲时，它会产生大声的、不寻常的呼啸声。解释并研究这一现象。

8. 另一种磁悬浮

将一个大圆盘形磁铁放在非磁性导电板上。当一个小磁铁在盘子下面移动时，上面的磁铁可能会在某些条件下悬浮起来。研究这种悬浮以及上面磁铁的可能运动。

9. 果汁太阳能电池

使用导电玻璃片、碘、果汁（例如黑莓）和二氧化钛可以制造出一种功能性的太阳能电池，这种电池被称为 Grätzel 电池。制造这样一个电池并研究获得最大效率所必需参数。

10. 磁性齿轮

取几个相同的指尖陀螺，在它们的两端粘上钕磁铁。如果你将它们并排放在一个平面上，旋转其中一个，剩下的就会开始旋转，这完全是由于磁场的作用。研究并解释这一现象。

11. 吸管水泵

可以通过将一根吸管折成三角形并在顶点处剪开，来制作一个简单的水泵。当这样一个三角形被部分浸入水中，其中一个顶点围绕垂直轴旋转时，水可以通过吸管向上流动。研究几何形状和其他相关参数如何影响水泵的抽水速度。

12. 肥皂螺旋

将一根压缩的螺旋弹簧放入肥皂溶液中，然后将其拉出并拉直。在弹簧的各个圈之间会形成一层肥皂膜。如果肥皂膜的完整性被破坏，膜的前端就会开始移动。解释这一现象，并研究肥皂膜前端的活动情况。

13. 充电表

在两个带电板之间的区域中，用一个线悬挂一个轻质球。如果球也带电，它会被偏转到一侧一定角度。这种设备用于测量球上电荷的准确性如何？优化你的设备以测量球上尽可能小的电荷。

14. 尺子戏法

在桌子边缘放一把尺子，向尺子自由端投掷一个球。尺子会倒下。但是，如果你用一张纸盖住尺子的一部分并重复投掷，那么尺子就会留在桌子上，而球会弹开。解释这一现象，并研究相关参数。

15. 湿卷曲

轻轻地将一块描图纸放在水面上。它会迅速卷成卷，然后慢慢地展开。解释并研究这一现象。

16. 缓冲弹射器

将一个物体放在大型空气垫上，以抛射的方式放下几个其他物体，使第一个物体被弹射出去。研究出口速度如何依赖于相关参数。

17. 量子调光器

如果在含有食盐的火焰前放一盏汽化钠灯，火焰会投射出阴影。如果将火焰放入强磁场中，阴影可以变得更亮。研究并解释这一现象。