



# Problems for the 37th IYPT 2024

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## 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?

### 1. 自己发明

拿一个盒子(如火柴盒)来说，里面装满了相同的东西(如火柴、球等)。找到一种仅通过摇晃盒子时产生的声音，来确定盒子中物体数量的方法。研究这种方法的精确度是如何取决于物体、盒子和包装密度等性质的？

## 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.

### 2. 液滴显微镜

透过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。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.

### 3. 刚性坡道行走器

建造一个有四条腿的刚性坡道行走器（例如梯形的样式）。该结构可能开始沿粗糙的斜坡向下“行走”。研究行走器的几何形状以及相关参数是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.

### 4. 电荷测量计

一个轻球被一根线悬挂在两个带电板之间的区域。如果球也带电，它会以一定的角度偏向一侧。这种测量球上电荷量的装置的精度是多少？优化你的设备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?

### 5. 乒乓球火箭

将一个乒乓球放在装水的容器中。当容器掉落时，乒乓球将被发射到一个很高的高度。使用最多 2 升水，你能达到的最大高度是多少??

#### 6. Non-contact Resistance

The responses of an 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?

#### 6.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.

#### 7.巨型发声板

当一个又大又薄又有弹性的板(如塑料、金属或有机玻璃)被弯曲时，它可能会发出一种响亮而不寻常的呼啸声。解释并探究这一现象。

#### 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.

#### 8.另一类磁悬浮

将一个大的圆盘形磁铁放在一个非磁性导电板上。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。探究此类磁悬浮现象和上面磁铁可能的运动。

#### 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.

#### 9. 果汁太阳能电池

一个功能性的太阳能电池可以用导电玻片、碘、果汁(例如黑莓)和二氧化钛来制备。这种类型的电池单元称为 Grätzel 电池。制作这样一个电池，并探究必要的参数以获得最大的效率。

#### 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.

#### 10.磁力齿轮

拿几个相同的指尖陀螺，在它们的末端贴上钕磁铁。如果你把它们并排放在一个平面上，并旋转其中一个，剩下的就会因为磁场而开始旋转。探究并解释这一现象。

#### 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.

#### 11. 吸管水泵

一个简单的水泵可以用一根吸管折成三角形，并在顶点处切开来实现。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。探究几何形状和其他相关参数是如何影响抽速的。

#### 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.

#### 12.肥皂螺旋

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

#### 13. Shooting Rubber Band

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

#### 13.射击橡皮筋

如果橡皮筋在射击时不均匀拉伸，使其旋转，则可以飞得更远。优化带旋转的橡皮筋能到达的距离。

#### 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.

#### 14. 尺子魔术

将一把尺子放在桌子边上，并向其自由端扔一个球。尺子会掉下来。然而，如果你用一张纸盖住尺子的一部分并重复投掷，那么尺子将保持在桌子上，而球将被它弹起。解释这一现象，并探究相关参数。

#### 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.

#### 15.湿纸卷

轻轻地将一张描图纸放在水面上。它迅速卷成一个纸卷，然后慢慢展开。解释并探究这一现象。

#### 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.

#### 16.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。研究出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 vapor 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.

### 17.量子调光器

如果你把添加了食盐的火焰放在蒸汽钠灯前，火焰会投射出阴影。如果火焰被置于强磁场中，影子会变得更浅。探究并解释这一现象。