

## 2023CUPT 题目:

(参加选拔的同学 1 到 10 题任选其中 1 题写出研究计划)

### 1、Fractal Fingers 分形手指

The effect of fractal fingering can be observed if a droplet of an ink-alcohol mixture is deposited onto diluted acrylic paint. How are the geometry and dynamics of the fingers influenced by relevant parameters?

如果将一滴油墨和酒精的混合物滴在稀释的丙烯酸涂料上，就可以观察到分形手指效应。手指的几何形状和动力学特征将如何受相关参数影响？

### 2、Oscillating Sphere 振荡球

A light sphere with a conducting surface is suspended from a thin wire. When the sphere is rotated about its vertical axis (thereby twisting the wire) and then released, it starts to oscillate. Investigate how the presence of a magnetic field affects the motion.

一个表面导电的轻球悬挂在一根细导线上。当球绕着其垂直轴旋转（从而扭转导线）并释放，它会开始振荡。研究磁场的存在会如何影响这一运动。

### 3、Siren 汽笛

If you direct an air flow onto a rotating disk with holes, a sound may be heard. Explain this phenomenon and investigate how the sound characteristics depend on the relevant parameters.

如果你将气流导向旋转的有孔圆盘，会听到声音。解释此现象并研究此声音的特征如何取决于相关参数。

#### **4、Coloured Line 彩色线**

When a compact disc or DVD is illuminated with light coming from a filament lamp in such a way that only rays with large angles of incidence are selected, a clear green line can be observed. The colour varies upon slightly changing the angle of the disc. Explain and investigate this phenomenon.

当只选用白炽灯光中入射角较大的光照射光盘或 DVD 时，会出现一条明显的绿色线。光盘的角度稍有改变，颜色就会发生变化。解释并研究此现象。

#### **5、Whistling Mesh 口哨网**

When a stream of water hits a rigid metal mesh within a range of angles, a whistling tone may be heard. Investigate how the properties of the mesh, stream and angle affect the characteristics of the sound produced.

当水流在一定角度范围内冲击刚性金属网时，可能听到口哨声。研究金属网、水流的性质及角度大小将如何影响声音的特征。

#### **6、Magnetic-Mechanical Oscillator 磁机械振荡器**

Secure the lower ends of two identical leaf springs to a non-magnetic base and attach magnets to the upper ends such that they repel and are free to move. Investigate how the movement of the springs depends on relevant parameters.

将两个相同的叶片弹簧下端固定在一个无磁基座上，并将两块磁铁吸附在弹簧上端，使他们相互排斥且可以自由移动。研究弹簧的运动如何取决于相关参数。

## 7、Faraday Waves 法拉第波

A droplet of less viscous liquid floating in a bath of a more viscous liquid develops surprising wave-like patterns when the entire system is set into vertical oscillation. Investigate this phenomenon and the parameters relevant to the production of stable patterns.

当整个系统处于垂直振荡状态时，一滴低粘度液体漂浮在一团粘性较强液体中，会产生令人惊讶的波形图案。研究此现象以及与形成稳定图案有关的参数。

## 8、Euler's Pendulum 欧拉摆

Take a thick plate of non-magnetic material and fix a neodymium magnet on top of it. Suspend a magnetic rod (which can be assembled from cylindrical neodymium magnets) underneath it. Deflect the rod so that it touches the plate only with highest edge and release it. Study the motion of such a pendulum under various conditions.

取一块厚的、由非磁性材料制成的板，并在其上面固定一个钕磁铁。在板的下方悬挂一根磁性杆（可以由多块圆柱形钕磁铁组装制成）。使杆偏转至它只有最顶部的边沿接触到板，然后将其释放。研究这种摆在各种条件下的运动。

## 9、Oscillating Screw 振荡的螺丝

When placed on its side on a ramp and released, a screw may experience growing oscillations as it travels down the ramp. Investigate how the motion of the screw, as well as the growth of these oscillations depend on the relevant parameters.

当把一颗螺丝侧放在斜面上并释放时，螺丝可能会在沿着斜面向下运动时产生越来越大的振荡。研究螺丝的运动以及这种振荡的增长如何取决于相关参数。

### **10、Upstream Flow 逆流而上的运动**

Sprinkle light particles on a water surface. Then allow a water stream to be incident on the surface from a small height. Under certain conditions, the particles may begin to move up the stream. Investigate and explain this phenomenon.

在水面上撒上轻质颗粒，然后让水流从很小的高度入射水面。在一定条件下，微粒可能会沿水流向上运动。研究并解释这一现象

### **11、Ball on Ferrite Rod 铁氧体棒上的球**

A ferrite rod is placed at the bottom end of a vertical tube. Apply an ac voltage, of a frequency of the same order as the natural frequency of the rod, to a fine wire coil wrapped around its lower end. When a ball is placed on top of the rod, it will start to bounce. Explain and investigate this phenomenon.

把一个铁氧体棒放在垂直管的底部。把频率与棒的固有频率同阶的交流电压施加到缠绕在棒下方的细线圈上。当把一个球放在棒的上方时，球将会开始弹跳。解释并研究这个现象。

### **12、Rice Kettlebells 大米壶铃**

Take a vessel and pour some granular material into it, for example, rice. If you dip e.g. a spoon into it, then at a certain depth of immersion, you can lift the vessel and contents by holding the spoon. Explain this phenomenon and explore the relevant parameters of the system.

向一个容器中倒入一些颗粒状物质（例如大米）。如果把勺子等物体浸入颗粒状物质中，在一定的浸入深度下，可以通过提起勺子来提起容器和其中的颗粒。解释这个现象并探究系统的相关参数。

### **13、Pony's Heat Tube 波妞的加热管**

A glass tube with a sealed top is filled with water and mounted vertically. The bottom end of the tube is immersed in a beaker of water and a short segment of the tube is heated. Investigate and explain the periodic motion of the water and any vapour bubbles observed.

把一个顶部密封的玻璃管装满水并垂直安装。把玻璃管的底端浸入装有水的烧杯中，使玻璃管的一小段被加热。研究并解释水和观察到的气泡的周期性运动。

### **14、Jet Refraction 射流的折射**

A vertical jet can be refracted when passing through an inclined sieve with a fine mesh. Propose a law for such refraction and investigate relevant parameters.

垂直射流通过带有细网的斜筛时会发生折射。为这种折射提出一个定律并研究相关参数的影响。

### **15、Pancake Rotation 煎饼的旋转**

Place a few balls in a round container. If you move the container around a vertical axis, the balls can move codirectionally with the movement of the

container, or they can move in the opposite direction. Explain this phenomenon and investigate how the direction of movement depends on relevant parameters.

将几个球放在一个圆形容器中。如果绕一个竖直轴移动容器，球可以与容器运动方向同向移动，也可以向容器运动方向的反方向运动。解释这个现象并研究运动方向如何取决于相关参数。

### **16、Thermoacoustic Engine 热声发动机**

A piston placed in the open end of a horizontal test tube which has its other end partially filled with steel wool may oscillate when the closed end is heated up. Investigate the phenomenon and determine the efficiency of this engine.

把一个活塞放在水平放置的试管的开口端，试管的封闭端则用钢丝绒部分填充。当试管的封闭端被加热时，活塞可能会振动。研究这个现象并确定这个发动机的效率。

### **17、Arrester Bed 沙地**

A sand-filled lane results in the dissipation of the kinetic energy of a moving vehicle. What length is necessary for such an arrester bed to entirely stop a passively moving object (e.g. a ball)? What parameters does the length depend on?

被沙子覆盖的车道会导致行驶车辆的动能损耗。如果要使一个被动运动的物体（如一个球）完全停止，这样的沙地需要多长？长度又取决于哪些参数？