Problems for the 36th IYPT 2023

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（校赛/国赛赛题）

赛事以普通话为工作语言，赛题以英文原文为准，中文翻译仅供参考。

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?

如果将一滴墨水-酒精混合物沉积在稀释的丙烯酸涂层上，可以观察到形如分开的手指的图案。探究手指的几何形状和动态如何被相关参数影响。

2. Oscillating Sphere 摆球

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.

将一个表面导电的轻球悬挂在一根细电线上，当球体绕其垂直方向旋转（从而使电线转动扭曲）后释放，则轻球可能会发生振荡。研究磁场的存在对该运动的影响。

3. Siren 汽笛警报

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.

如果把气流引到一个有孔的旋转盘上，可能会听到声音。解释这一现象，并研究声音特征所依赖的相关参数。

4. Coloured Line 彩线

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.

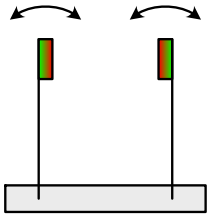
当由灯管发出的光以大入射角入射光盘或 DVD 时，可以观察到一条清晰的绿线。线的颜色将随着入射角度的改变发生变化。解释并研究这一现象。

5. Whistling Mesh 网哨

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.

当水流在以一定的角度范围撞击刚性金属网时，可能会听到呼啸的声音。研究产生声音的特点与网、水流和入射流角度的关系。

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.

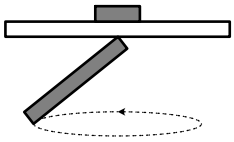
将两个相同的片簧的下端固定在一个非磁性的底座上，并将磁铁固定在上端，使它们相互排斥并自由运动。研究弹簧的运动与相关参数的依赖关系。

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.

当整个系统发生垂直振荡时，漂浮在粘性更高的液体中的一滴低粘度液体会呈现神奇的波浪状图案。研究这一现象以及与产生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.

取一块非磁性材料的厚板，在其上面固定一块钕磁铁。在其下方悬挂一根磁棒（可由圆柱形的钕磁铁组合而成）。使磁棒偏转，使其只有最高处的边缘接触到板子，然后释放它。研究这种摆锤在不同条件下的运动。

9. Oscillating Screw 螺丝摆

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.

当把一个螺丝放在斜坡上并松开时，它沿着斜坡向下运动的同时可能会产生越来越大的振荡。研究螺丝的运动，以及这些振荡的增长所依赖的相关参数。

10. Upstream Flow 上游流

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.

在水面上撒下轻质颗粒，并使水流由较小的高度入射到水面上。在某些条件下，颗粒可能开始沿水流向上移动。研究并解释这一现象。

11. Ball on Ferrite Rod 棒上球

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.

一根铁氧体棒被放置在一个垂直管的底端。给缠绕在铁氧体棒下端的细线线圈施加一个频率与棒的固有频率相同的交流电压。当一个球被放在棒的顶部时，它将开始弹跳。解释并研究这一现象。

12. Rice Kettlebells 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.

取一个容器，将一些颗粒状物质倒入其中，例如米。如果将一个棒（例如一个勺子）浸入其中，那么在一定的浸入深度下，你可以通过勺子同时举起容器和内容物。解释这一现象并探索系统的相关参数。

13. Ponyo's Heat Tube 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.

将一根装满水的、顶部密封的垂直玻璃管的底端浸入装水的烧杯中，对玻璃管的一小段进行加热。研究并解释水和观察到的气泡的周期性运动。

14. Jet Refraction 折射流

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.

一束垂直射流通过带有细网的斜筛时，会发生折射。总结提出这类折射的规律并研究相关参数。

15. Pancake Rotation 旋转饼

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.

将几个球放入圆形容器中。如果围绕垂直轴移动容器，则球可以随容器的移动一起同向移动，也可以沿相反方向移动。解释这种现象，并研究运动方向取决于哪些相关参数。

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.

将一个活塞放在水平放置的试管的开口端，试管另一端封闭端部分用钢丝绒填充。当试管封闭端被加热时，活塞可能会振动。研究该现象并确定该发动机的效率。

17. Arrester Bed 减速沙地

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?

一条充满沙子的车道可以降低车速。这样的车道需要多长才能使一个物体（例如一个球）完全停下？该长度取决于哪些参数？