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SMSYPT 2022

Prompts & (useful, hopefully,) Hints

Question proposed by *Discovery Physics* advisors:

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Figure 0: “Add Oil!” (“You’ve got this! Good luck” :)

I Problems

1. 拯救鸡蛋 Save The Eggs

设计一种可以在坠落中保护鸡蛋的装置，在自由落体之后保护一个生鸡蛋不坏。自由下落高度是 2.5 米。装置必须和鸡蛋一起下落。优化你的装置使其尽可能小。

Design a device that protects a raw egg from breaking after free fall. The freefall height is set to be 2.5 meters. The device must be dropped with the eggs. Optimize your device to make it as small in size as possible.

2. 硬币塔 Tower Of Coins

将相同形状的薄片（例：硬币）竖直搭成一摞。当一个冲量加到塔底部的物体上时，可能使此物体飞出而其上方的塔保持直立状态下落。研究使塔保持直立的相关参数。

Flakes of the same shape (e.g. coins) are stacked vertically. When an impulse is applied to an object at the bottom of the tower, it may cause the object to pop out while the tower above it remains upright and falls vertically afterwards. Study the relevant parameters that keep the tower upright.

3. 不倒翁 The Tough Tumbler (Roly-poly Toy)

在空塑料瓶的底部粘上一块橡皮泥，铺满瓶底。抛出空瓶，使其在空中翻滚，在一定条件下瓶子会直立着落地。研究这种现象的相关参数并探讨成功率最大的情况。

Stick a piece of plasticine at the bottom of the empty plastic bottle, fully pave the bottom of the bottle and throw the empty bottle, so that it rolls in the air. Under certain conditions, the bottle will land upright after the projectile motion. Study the relevant parameters of this phenomenon and

explore the situation with the maximum success rate.

4. 投石机 The Ancient Mangonel

众所周知，杠杆可以用于投掷物体。但是在现实中，物体投掷的远近由多种因素决定。现有一杠杆和一支点，释放一重物压杠杆一端使另一端的物体飞出。量化这个过程，并研究其变化的趋势。

We all know (or, at least “supposed to know”) that levers can be used to hurl/cast/through objects, but in reality, how far things are thrown is determined by a number of factors. Let’s say you now have a lever and a fulcrum. Release a weight and push one end of the lever so as to pop out the object at the opposite end of the lever. Quantify how different factors change in the process.

II Hints

1. 拯救鸡蛋

开放题，注意鸡蛋本身所能承受的最大作用力。

This is an open-ended question. Remember to pay attention to the maximum force F_{\max} that the egg itself can withstand.

2. 硬币塔

为什么塔会保持直立落地？

为什么塔不会保持直立落地？

设计你的实验装置以量化冲量？

Why does the tower stay upright and does not fall to the ground? Why does the tower, then, may not stay upright and land? Design your experimental set-up's to first conceptually understand and quantify the impulse, which can be shown as $J_{\text{total}} = J(\theta, \varphi, l, h, \dots)$.

3. 不倒翁

考虑一种简单的情况：把瓶子直接放在桌上，怎样能立起来？怎样最容易立起来？

塑料瓶与桌面的摩擦和碰撞如何处理？（在无法完成精确定量的分析时，作趋势的分析也不失为一种合理的方法）

Consider a simple case first: How can a bottle stand up when placed directly on the table? What is the easiest way to let it stand straight up? How to deal with the friction and collision between the plastic bottle and the table top? (When precisely and quantitatively analyzing may not be quite possible, try trend analysis, which also is a reasonable method to consider)

4. 投石机

石块抛出的角度和速度如何计算？

实验材料如何选择？

如何确定落地位置？

优化你的实验装置以精确化实验数据。

How can the angle and velocity of the rock thrown be calculated? How to select experimental materials beforehand? How to determine the landing position? Optimize your set-up's to refine your data collection.

-End of Questions-

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