活動名稱: 智慧陀螺儀挑戰賽

Activity name: Smart Gyroscope Challenge

校名:高雄市大仁國中

School name: Kaohsiung Municipal Taren Junior High School

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一、活動旨趣 / Activity Purpose

此活動旨在讓學生探索陀螺儀的基本原理,並引入人工智慧(AI)的應用,利用 Phyphox 測量物體運動中的角速度,提升學生對物理和科技的綜合理解。
This activity aims to allow students to explore the basic principles of gyroscopes and introduces the application of artificial intelligence (AI). By using Phyphox to measure angular velocity in object motion, the activity enhances students' comprehensive understanding of both physics and technology.

二、活動器材 / Activity Materials

陀螺儀、支架、平板 、鐵鍊、繩子、Phyphox 應用程式、轉盤
gyroscope、stand、iPad、chain、rope、Phyphox app、turntable
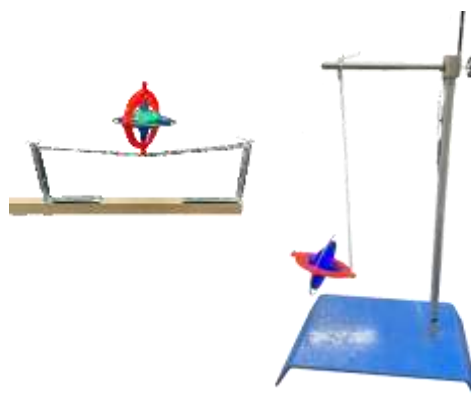
三、挑戰任務 / Challenge task

任務 1:使陀螺儀在鐵鍊上旋轉

Task 1: Let the gyroscope spin on the chain.

任務 2:使陀螺儀在對折的繩子上旋轉

Task 2: Let the gyroscope spin on the folded rope.

任務 3:在轉盤上旋轉 iPad,並使用 Phyphox 應用程式測量它的角速度。

Task 3: Spin the iPad on a turntable and use the Phyphox app to measure its angular velocity.

Task 4: Explain the principle of gyroscope rotation.
The answer is conservation of angular momentum.

三、原理解釋 / Explanation of Principle

(一) 角動量守恆原理

Principle of Conservation of Angular Momentum

定義 / Definition

如果作用在系統上的外部力矩為零，則系統的角動量恆定。我們騎腳踏車的時候其實就是在用這個原理。輪子轉得越快，掉下來的可能性就越小，因為車軸有一個力使它保持水平。

If the external torque acting on a system is zero, then the angular momentum of the system is constant.This principle is actually utilized when riding bicycles.The faster the wheel spins, the less likely it is to fall off due to the force exerted   on the axle , which   helps to keeps it level.

數學表達式

如果 L 是系統的總角動量，則：$L_{初} = L_{末}$ 即初始角動量等於最終角動量。

角動量的計算

角動量 L 可以用以下公式計算：$L = r \times p$ 其中 r 是位置向量，p 是動量。

Mathematical Expression

If L is the total angular momentum of the system, then: $L_{initial} = L_{final}$ This means the initial angular momentum equals the final angular momentum.

Calculation of Angular Momentum

Angular momentum L can be calculated using the following formula: $L = r \times p$ where r is the position vector and p is the momentum.

(二)陀螺儀的基本構造 / Basic Structure of a Gyroscope

1. 轉子 / Rotor
   中心旋轉的輪子或圓盤，產生角動量。The central spinning wheel or disc, which generates angular momentum.
2. 軸 / Axle
   轉子繞著其旋轉的軸，通常以高速旋轉。The axis around which the rotor spins, typically at high speed.
3. 萬向節 / Gimbals
   支撐轉子的樞軸結構，允許轉子向不同方向傾斜。典型的陀螺儀具有兩個或三個萬向節，使其無論基座如何移動，都能保持穩定的方向。
   Pivoted supports that allow the rotor to tilt in various directions. A typical gyroscope has two or three gimbals, allowing it to maintain its orientation regardless of the movement of its base.
4. 外框 / Frame
   固定萬向節和轉子的結構。The outer structure that holds the gimbals and rotor in place.

(三)使用 **Phyphox** 應用程式測量角速度
Use the Phyphox app to measure angular velocity

步驟 1:下載並安裝 Phyphox
Step 1:Download and Install Phyphox
到 Apple App Store 搜索並下載 Phyphox 應用程式。
Search for and download the Phyphox app from Google Play or the Apple App Store.

步驟 **2:**開啟 Phyphox 應用

Step 2: Open the Phyphox App

安裝完成後，打開 Phyphox 應用，你會看到主頁上的一系列物理實驗。

After installation, open the Phyphox app. You will see a list of physical experiments on the main page.

步驟 **3:**選擇 "陀螺儀" 實驗

Step 3:Select the "Gyroscope" Experiment

在實驗列表中，找到並選擇 "Gyroscope"（陀螺儀） 實驗。這個實驗可以測量手機內置的陀螺儀傳感器數據，主要是角速度。

In the list of experiments, find and select the "Gyroscope" experiment. This experiment measures the data from the phone's built-in gyroscope sensor, mainly rotational speed.

步驟 **4:**開始測量角速度

Step 4:Start Measuring Angular Velocity

當你進入實驗界面後，應用會立即開始讀取手機內的陀螺儀數據，顯示角速度的三個分量（X、Y、Z 軸的角速度），單位是度/秒或弧度/秒。

Once you enter the experiment interface, the app will immediately start reading the gyroscope data from the phone, showing the angular velocity components along the X, Y, and Z axes in degrees per second or radians per second. You will see changes in angular

四、生活應用 / Life application

當陀螺儀旋轉時，它的方向會基於角動量守恆原理保持穩定。這種抵抗方向變化的特性，使陀螺儀廣泛應用於導航與穩定控制。陀螺儀技術廣泛應用於現代科技中，如飛機和船隻的導航系統、智能手機的姿態感測，以及衛星的姿態控制系統。

When the gyroscope spins, its orientation remains stable due to the principle of conservation of angular momentum. This resistance to change in orientation makes gyroscopes useful for navigation and stabilization.Gyroscope technology is widely used in modern technology, such as in the navigation systems of airplanes and ships, attitude sensing in smartphones, and attitude control systems in satellites.

五、參考資料 / References

https://byjus.com/physics/gyroscope/