活動名稱：物理玩很大

Event name：
Playing Physics is great

校名：高雄市立正興國中

School name : Kaohsiung Municipal Jhengsing Junior High School

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一、旨趣 Purpose

本關卡藉由動手玩趣味遊戲以達到科學探索學習之目的。在關卡中，利用生活中的諸多小物品，透過簡單的動手操作，去發現並體驗三個奇妙有趣的物理現象，以進一步了解深奧的物理原理。

This level try to reach the purposes of scientific exploration and learning through hands-on fun activities.

In the levels, you can use many small items in life and simple hands-on operations to discover and experience three wonderful and interesting physical phenomena to further understand the profound physical principles.

二、闖關活動 Breakthrough activities

第一關 ： 立筆趣

材料 ： 鉛筆、鐵絲、螺帽、螺絲釘、木製平台、玻璃平板

活動設計 ： 你能不能讓鉛筆站立起來呢？而且是用筆尖立在桌角和指尖，並且輕碰就算搖晃也不會倒喔！請使用所提供的用具，讓鉛筆站立起來即可過關！

進階挑戰 ：在「光滑」的玻璃面上，讓鉛筆站立即可過關!

Level 1 : The joy of letting the pen stand

Materials :

pencil, wire, nuts, screws, wooden platform, glass plate

Activity Design :

Can you make a pencil stand? And the pen tip is placed on the corner of the table and on your fingertips, and it will not fall over even if it shakes lightly! Please use the tools provided to make the pencil stand up to pass the level!

Advanced challenge :

Try to make the pencil stand on the "smooth" glass surface to pass the level!

第二關 ： 赤井秀一 No.1

材料 :雷射筆、平面鏡、凹面鏡、凸面鏡、凸透鏡、凹透鏡、光柵

活動設計 ： 關主將一位犯人放置在平台上某處，請闖關者擺置好各種鏡面(不限數量)，在雷射槍射擊後，其所發出的雷射光可以打中犯人即可過關！

進階挑戰 ： 關主將「數位犯人」放置在平台上某些地點，請闖關者擺置好各種鏡面(不限數量)，雷射槍射擊後可同時打中「數位犯人」就過關！

Level 2 : Akai Shuichi No.1

Materials :

laser pen, plane mirror, concave mirror, convex mirror, convex lens, concave lens, grating

Activity design :

The level master places a prisoner somewhere on the platform, and asks the level breaker to place various mirrors (no limit for the mirror numbers). After the laser gun is fired, the laser light should hit the prisoners and pass the level.

Advanced challenge :

The level master places "digital prisoners" at certain locations on the platform. Players are asked to place various mirrors (no limit for the mirror numbers). After firing the laser gun, the laser light should hit the "digital prisoners" at the same time to pass the level!

第三關 ： 漂漂球

材料 ：氣球、打氣筒、橡皮筋、螺絲釘、吹風機

活動設計 ：請闖關者使用打氣筒做出氣球，氣球下方用橡皮筋掛上數個螺絲釘後，以吹風機讓氣球在原地漂浮 10 秒後前進，將氣球投入大桶子後即可過關！

進階挑戰 ： 請闖關者以吹風機讓「寶特瓶」在原地漂浮 10 秒後前進，將「寶特瓶」投入大桶子後即可過關！

Level 3: Floating ball

Materials :

Balloons, pump, rubber bands, screws, hair dryer

Activity design :

Challengers are asked to use a pump to make a balloon. After hanging several screws with a rubber band under the balloon, use a hair dryer to make the balloon float in the same place for 10 seconds before moving forward. After putting the balloon into a big bucket, you can pass the level!

Advanced Challenge ：

Players are asked to use a hair dryer to make the "plastic bottle" float in the same place for 10 seconds before moving forward, and then put the "plastic bottle" into a large bucket to pass the level！

三、原理探討 Discussion of principles

第一關 ： 立筆趣

平衡玩具之所以會平衡，主要在於它是重心在支點位置下方的穩定平衡。不需力臂等長，也不必考慮物體輕重是否相同，神奇的是，透過操作調整，它們自會找到平衡點，使合力矩=0。

在操作過程中，不管鉛筆與桌面是怎樣的傾斜角度，要能穩定地立在桌邊，筆尖與螺絲均是成一直線。也就是說，透過鐵絲與螺絲協助，讓重心降低且讓它落在支點（筆尖）的下方，鉛筆

就能穩穩地立在桌角保持平衡！透過螺絲將整組裝置的重心移到筆尖（支點）的下方，就算鉛筆受到擾動以逆時鐘方向傾倒，重心也會自然產生回復力矩（逆時鐘方向），讓鉛筆像不倒翁一樣，即使搖晃～還是能穩定站立。

Level 1 : The joy of letting the pen stand

The main reason why a balanced toy can keep balance is that it has a stable balance with the center of gravity below the fulcrum. There is no need for the moment arms to be of equal length, and there is no need to consider whether the weight of the objects is the same. The magic is that through operation and adjustment, they will automatically find the balance point, so that the resultant moment = 0.

During operation, no matter what angle the pencil is tilted to the table, it is able to stand stably on the edge of the table, with the pen tip and screws in a straight line. In other words, with the help of wires and screws, the center of gravity is lowered and falls below the fulcrum (pen tip), and the pencil can stand firmly on the corner of the table and maintain balance! Move the center of gravity of the entire

device below the pen tip (fulcrum) through screws. Even if the pencil is disturbed and tilts clockwise, the center of gravity will naturally generate a restoring moment (counterclockwise), making the pencil like a tumbler, even if it shakes~ Still able to stand stably.

第二關 ： 赤井秀一 No.1

雷射是一種光源， 只是它發光的原理和一般光源不同，發出來的光就有它特別之處。一般光源是 經由「自發放射」，而雷射是以「受激放射」來發光的。雷射光的特色有：單一性(光色單純)；擴散性小(雷射光束細而直，幾乎不會向外擴散，雷射光向天空照射，即使傳播長距離，仍能保持直線，不會散開成錐狀)；集中性(雷射光具能量集中的特性，可直線集中前進；高能量(如果使用凸透鏡，可將雷射光集中於極微小的一點，而產生高能量密度；危險性(使用時眼睛絕不能直視雷射光源)。

光遇到障礙物或界面時，其能量有一些會返回原先通過的介質中，稱為反射；未被反射的能量，則隨著光進入障礙物或穿越界面，繼續前進，稱為透射。在透射後，光前進的方向通常會出現偏折，而與入射方向不同，稱為折射。所以當光照射到物體表面時，可能會出現下列的情形： 1.光被表面反射。 2.光穿過表面而透射或折射。 3.光被表面吸

收。光的「反射」與「折射」在中小學課程都有介紹，可以用鏡子、透鏡觀察光的反射與折射!

另一方面，當光照射並穿過間距極小(如光柵)的狹縫時，光會出現波動性質；亦即在穿過的過程中，光會以光波的性質穿越，而非以子彈(或粒子)的性質穿越狹縫。此時，每個穿過狹縫處的點光源所產生的光波，都可視為石頭丟到水面上所產生的漣漪向四周擴散；光波彼此間會如同漣漪般相互影響而有強度上的變化，使得在不同方向也可以獲得光的訊號；此即謂光的干涉現象。

Level 2 : Akai Shuichi No.1

Laser is a kind of light source, but the principle of its light emission is different from that of ordinary light sources, and the light it emits has its own special features. General light sources emit light through "spontaneous emission", while lasers emit light through "stimulated emission". The characteristics of laser light are: singleness (simple color of light); small diffusion (the laser beam is thin and straight, and hardly spreads outward. The laser light shines into the sky, and even if it travels over a long distance, it can still maintain a straight line without

spreading out into a cone shape); Concentration (laser light has the characteristic of energy concentration and can be concentrated in a straight line; high energy (if a convex lens is used, the laser light can be concentrated on a very small point, resulting in high energy density); Danger (Your eyes must not look directly into the laser light source during the use).

When light encounters an obstacle or interface, some of its energy will return to the medium it originally passed through, which is called reflection; the energy that is not reflected continues to move forward as the light enters the obstacle or crosses the interface, which is called transmission. After transmission, light is usually deflected in a direction different from the direction of incidence, which is called refraction. So when light hits the surface of an object, the following situations may occur: 1. The light is reflected by the surface. 2. Light is transmitted or refracted as it passes through a surface. 3. Light is absorbed by the surface. "Reflection" and "refraction" of light are introduced in primary and secondary school curriculum. You can use

mirrors and lenses to observe the reflection and refraction of light!

On the other hand, when light shines on and passes through slits with extremely small spacing (such as gratings), the light will exhibit wave properties; that is, during the process of passing through, the light will pass through as light waves rather than as bullets (or particles) crossing the slit. At this time, the light waves generated by each point light source passing through the slit and they can be regarded as ripples caused by throwing a stone on the water surface and spreading in all directions; the light waves will interact with each other like ripples and change in intensity,so light signals can be obtained in different directions; this is called the interference phenomenon of light.

第三關 ： 漂漂球

康達效應（Coanda Effect）又稱為「附壁作用」或柯恩達效應，是指流體遇到障礙物（例如氣球），流體會沿著障礙物曲面流動的現象，並產生推往流體方向的作用力。根據牛頓第三定律，物體施與流體一個偏轉的力，則流體也必定要施與物體一個反向偏轉的力。這種力在輕質物體上體現得非常明顯，如圖 1，氣球在吹風機的氣流中央時，由於氣流平均流經氣球的兩側，產生了大小一樣的向左與向右的作用力（紅色箭頭），因此能將氣球侷限在氣流中。如果氣球偏向吹風口右邊，如圖 2；由於氣球左邊的康達效應更明顯，因此向左的作用力大於向右的作用力，可以將氣球推回中央而再度保持平衡。

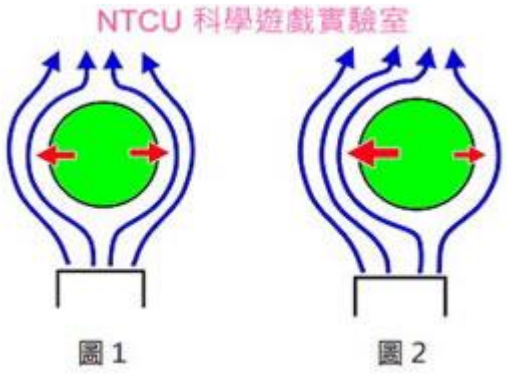

圖 1　　圖 2

康達效應不少人在生活中肯定遇到過，只是有的人沒有意識到而已。最常見的例子就是用湯勺來改變水流，如上右圖：圖中的例子很多人無意間會遇到，把勺子靠近水流後，水流改變了流動方向，被勺子吸引了過來。上面的實驗中，如果加大水流，就會看到勺子往右靠近。水流越大，靠近的越多。

原文網址：https://read01.com/BEnm7G.html

Level 3 : Floating ball

Coanda Effect refers to the phenomenon that when a fluid encounters an obstacle (such as a balloon), the fluid will flow along the curved surface of the obstacle and another force will push in the direction of the fluid. According to Newton's third law, if an object exerts a deflection force on the fluid, the fluid must also exert a reverse deflection force on the object. This force is very obvious on lightweight objects, as shown in Figure 1. When the balloon is in the center of the airflow of the hair dryer, the airflow flows through both sides of the balloon on average, producing the

same left and right forces (red arrow), thereby confining the balloon to the airflow. If the balloon deviates to the right of the blowing port, as shown in Figure 2; since the Coanda effect on the left side of the balloon is more obvious, the force to the left is greater than the force to the right, and the balloon can be pushed back to the center to maintain balance again.

Many people must have encountered the Coanda effect in their lives, but some people are not aware of it. The most common example is to use a spoon to change the flow of water, as shown in the picture on the right: Many people will encounter the example in the picture unintentionally. After bringing the spoon close to the water flow, the water flow changes direction and is attracted by the spoon. In the above experiment, if you increase the water flow, you will see the spoon move closer to the right. The bigger the current, the closer it gets.