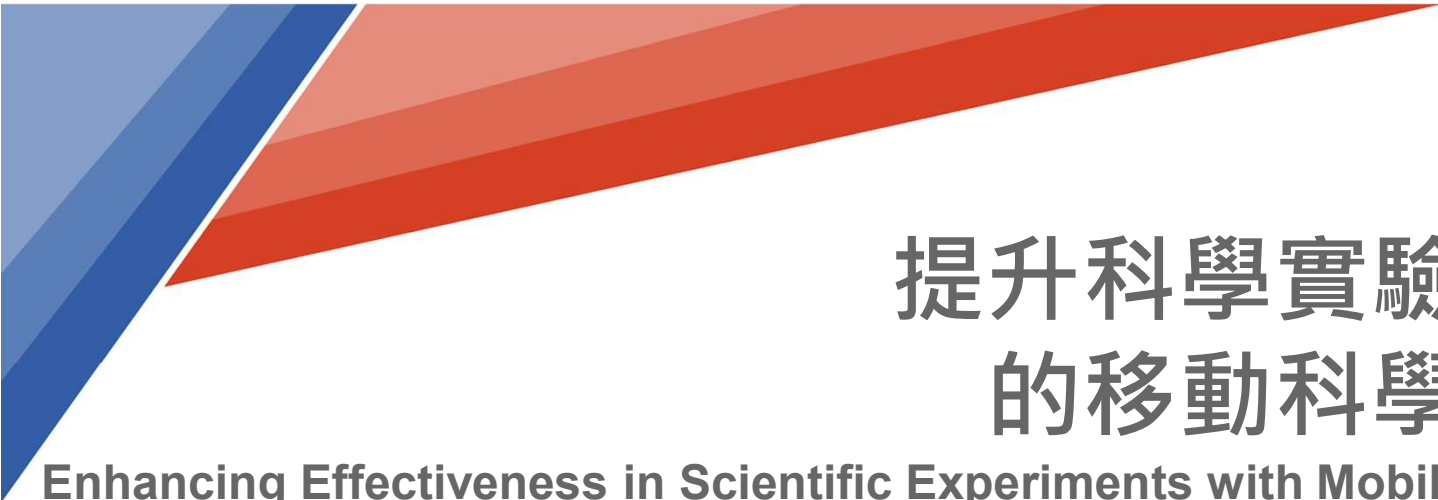




提升科學實驗教學效能 的移動科學實驗筆記

Enhancing Effectiveness in Scientific Experiments with Mobile Science Journal



青年會書院助理校長
梅志文先生



青年會書院科學科教師
彭鈺儀女士





青年會書院
Chinese YMCA College

Learning &
Teaching Expo 2019
學與教博覽2019



11 - 13 Dec 2019
Hall 3CDE, Hong Kong
Convention & Exhibition Centre

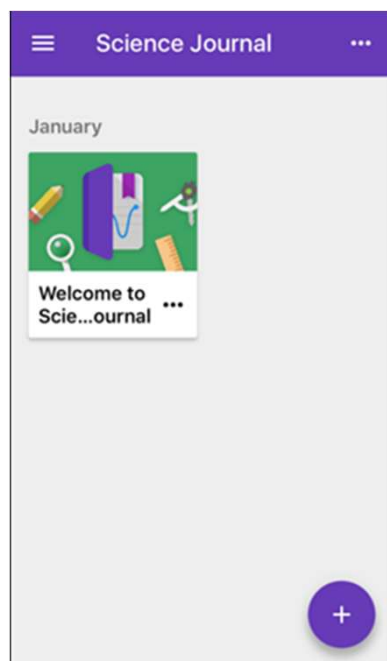
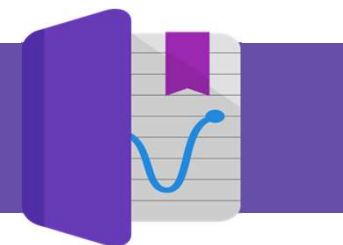
梅志文助理校長
彭鈺儀老師





Google Science Journal

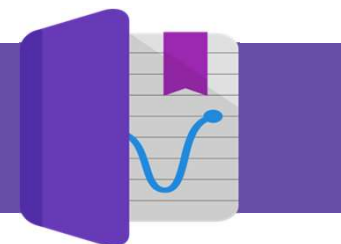
Google Science Journal 簡介



使用者可以為每一個實驗開啟不同的專案，即時記錄生活周遭各種有興趣的科學現象。

利用手機內部或外接感測器，來獲得亮度大小、聲音強弱、移動速度、氣壓、磁力等各種數據、立即製作成自己需要的圖表或報告。

Google Science Journal 下載及安裝

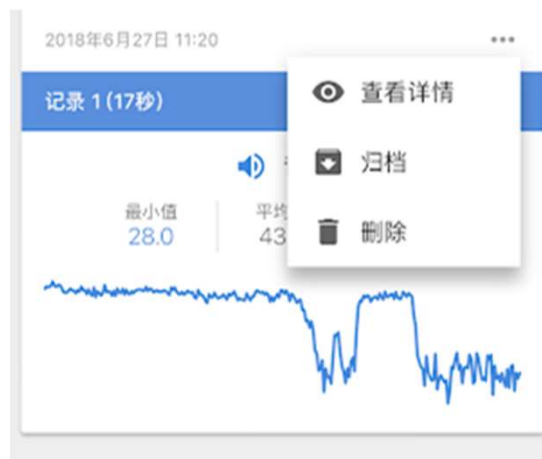
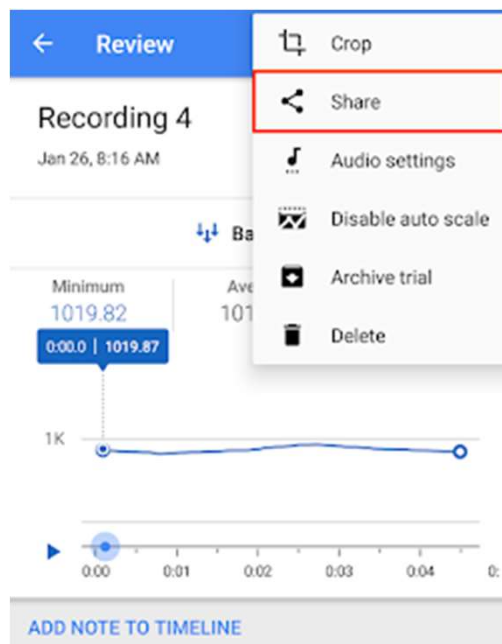


<https://sciencejournal.withgoogle.com/>



開啟Google Science Journal 第一步-驗證年齡

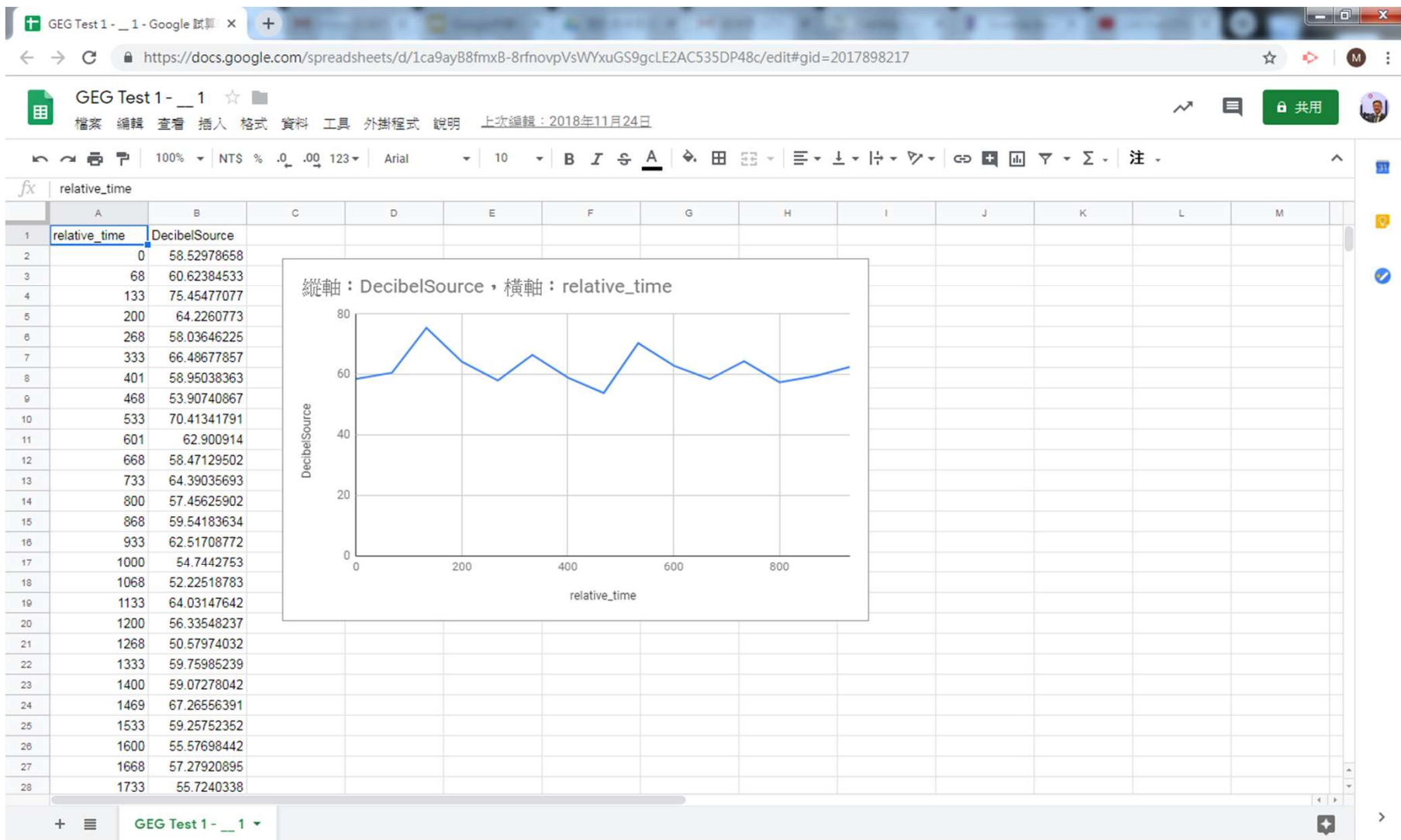
匯出功能只提供給16歲以上的使用者



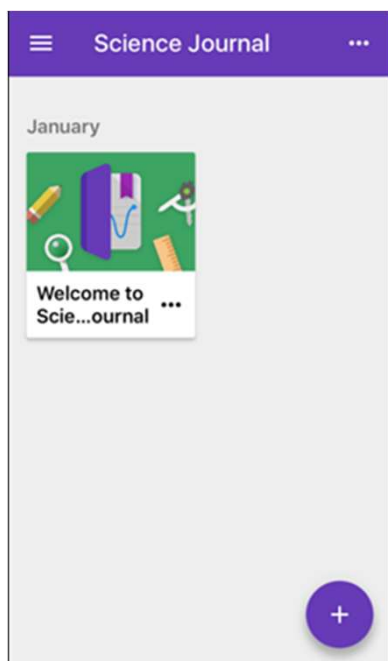
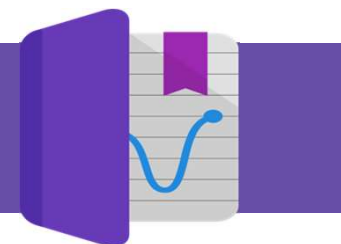
The screenshot shows the age verification screen in Google Science Journal. At the top, there's a blue bar with the title '验证您的年龄'. Below it, the text '出生日期:' (Birth date:) is displayed. A date picker is shown with the following options:

Year	Month	Day
2015年	8月	18日
2016年	9月	19日
2017年	10月	20日
2018年	11月	21日
2019年	12月	22日
2020年	1月	23日
2021年	2月	24日

At the bottom, there's a blue button labeled '开始使用' (Start using).

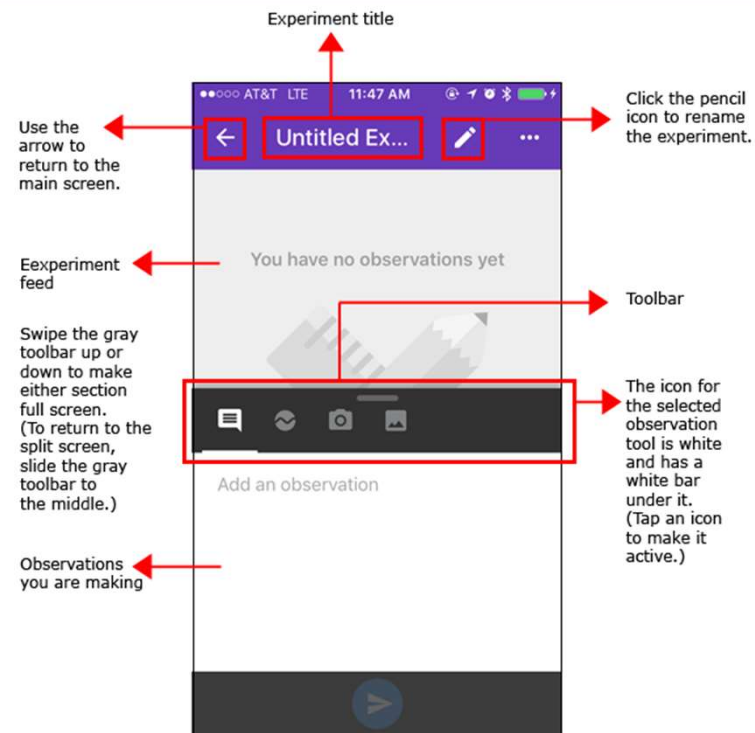
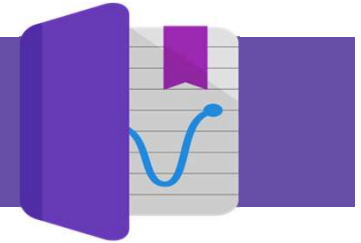


新增實驗



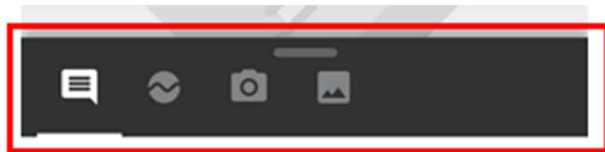
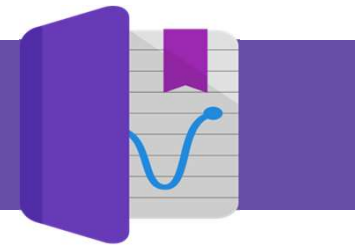
按「+」以新增實驗

Google Science Journal 界面



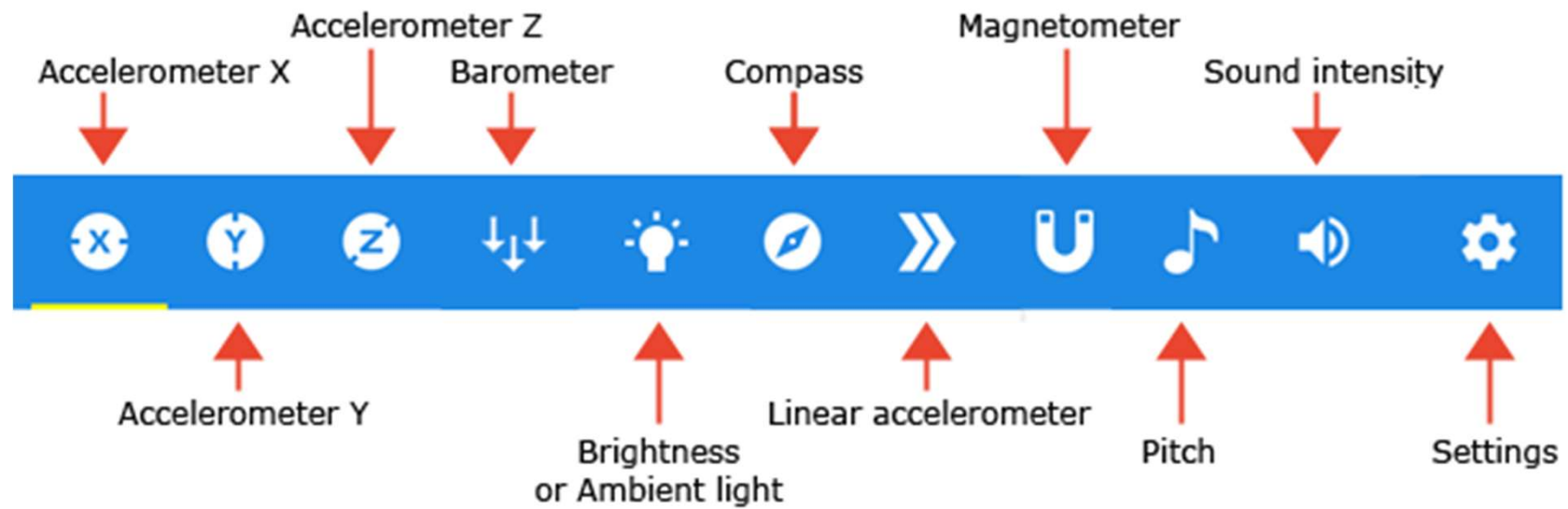
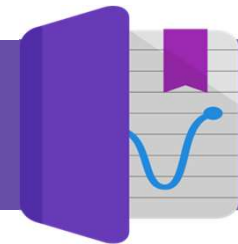
Source: <https://www.sciencebuddies.org>

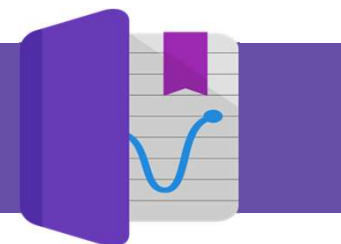
Google Science Journal



-  新增筆記
-  新增傳感器紀錄
-  拍攝
-  加入照片

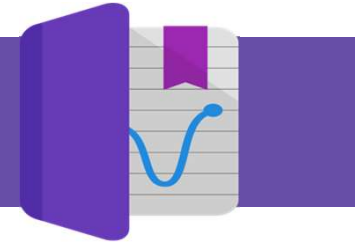
Google Science Journal





化學實驗

7 Ways to explore Chemistry with Google's Science Journal

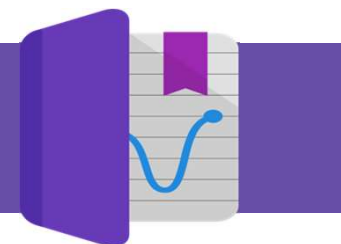


物理實驗

6

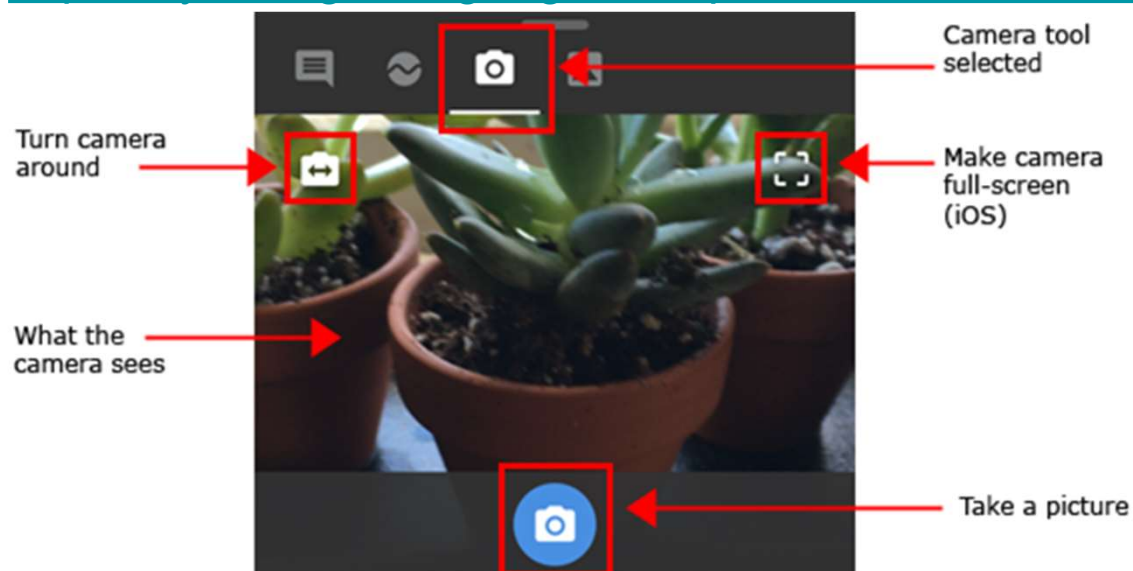
Ways to explore Physics
with
Google's Science Journal

Google Science Journal

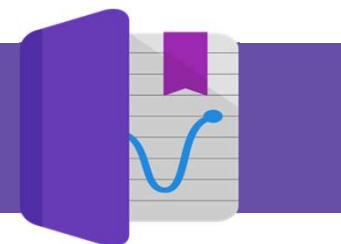


探究實驗 - 樹葉的透光度測試

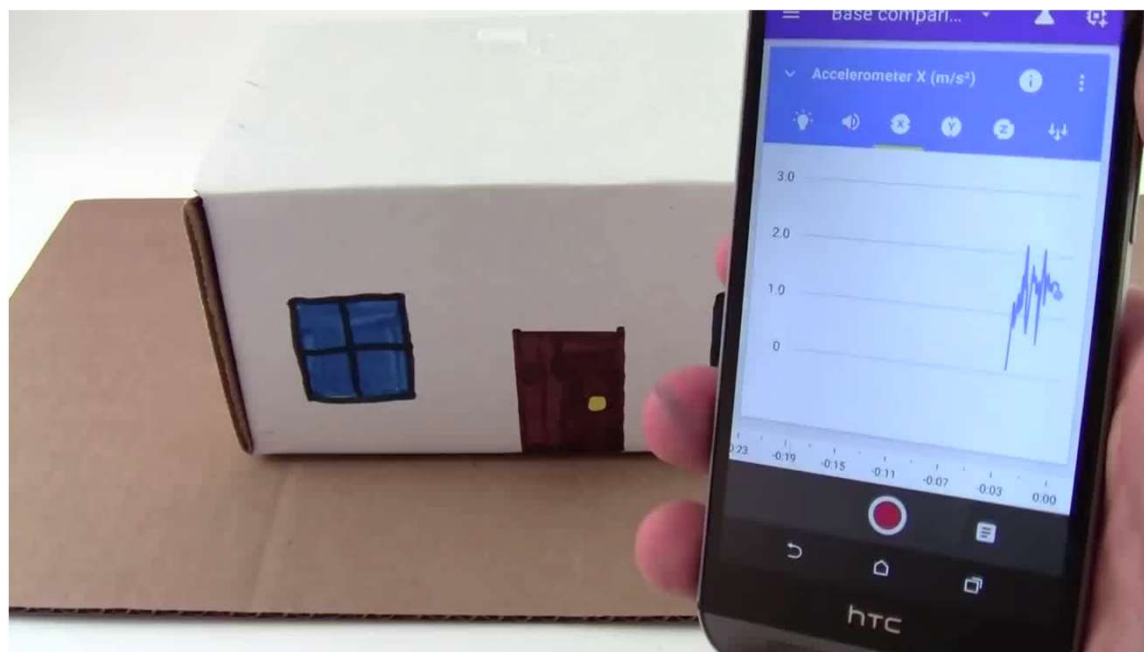
<https://nysci.org/sunlight-goes-exploration-tree-leaves/>



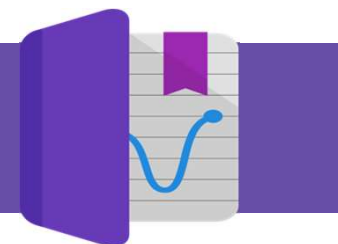
Google Science Journal



探究實驗 - 防地震建築



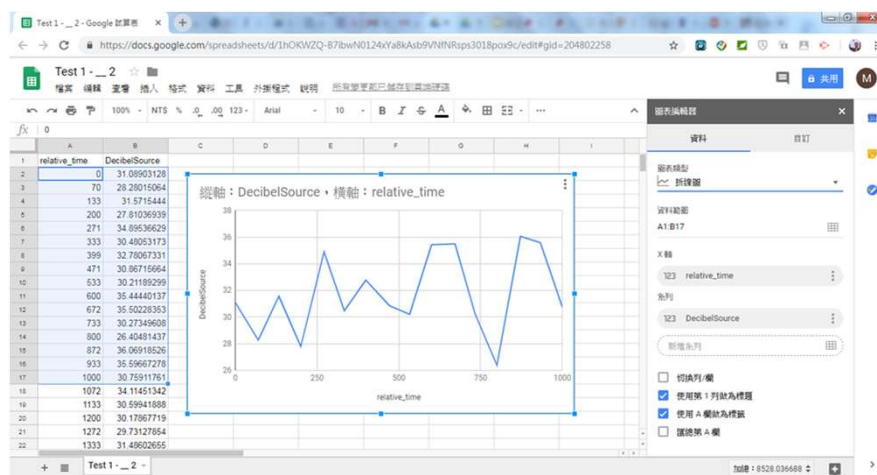
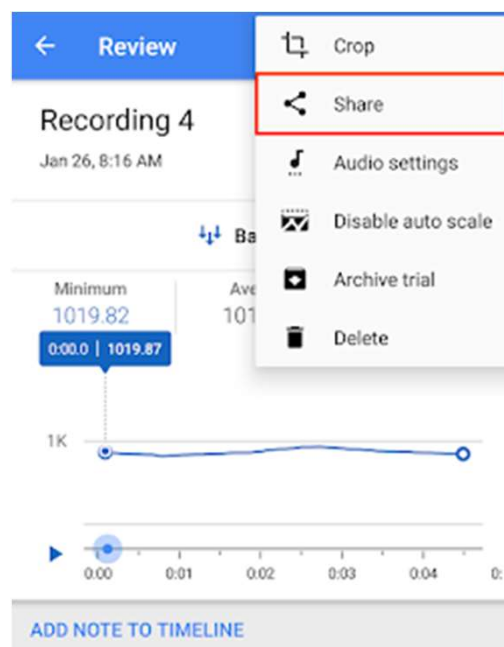
Google Science Journal 匯出功能



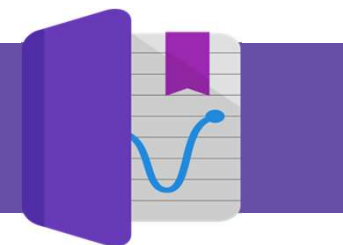
分享

> Google Drive

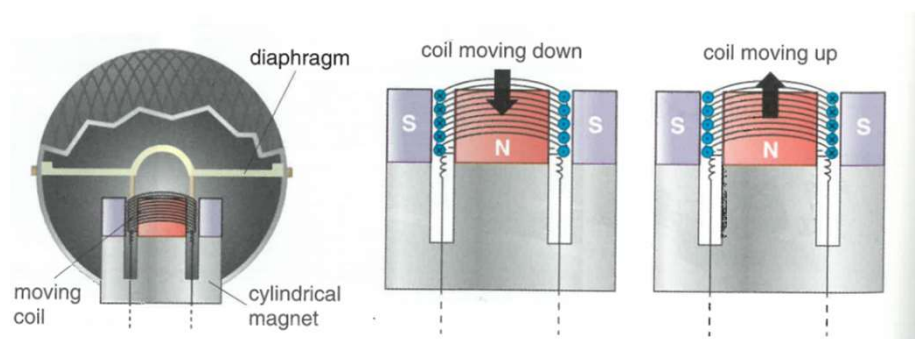
> 儲存成 CSV



教學分享1 聲音強度 Sound Intensity (dB 分貝)



- **量度:** 音訊感應器或麥克風接收到聲音的強度
- **原理:** 聲音由空氣振動所產生，麥克風將振幅轉變成電流後(Faraday's Law)，電流數據再經過程式處理，得出強度參考值，每部手機得出的數值有所不同。
- **手機應用:** 通話，錄音



聲音強度是指在接收聲波的物體表面上，每單位面積在每秒內所得到的能量，其單位為 W/m^2

$$dB = 10 \log (I / I_0)$$

$$I_0 = 10^{-12} \text{ Wm}^{-2}$$



教學分享1 聲音強度 Sound Intensity

教學內容

S2 IS Sensing the environment

活動1

- 量度生活中不同處境的聲音強度

活動2

- 量度聲音的傳遞距離對聲音強度的影響

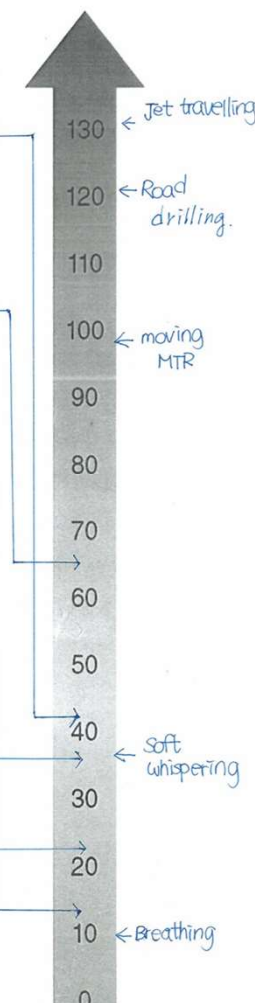


Activity 1

Sound is always surrounding us. Choose 5 daily events that you experience different sound levels. Using the mobile app "Science journal" to measure the sound level of that event for at least 5 seconds and record the results below.

1. Sound level the around my seat during IS lesson
① Duration = 5s
② Average value = 42 dB
③ Maximum value = 64 dB
④ Minimum value = 13 dB
2. Traffic sound on street
① Duration = 5s
② Average value = 65 dB
③ Maximum value = 76 dB
④ Minimum value = 52 dB
3. Sleeping environment
① Duration = 5s
② Average value = 13 dB
③ Maximum value = 39 dB
④ Minimum value = 12 dB
4. TV sound at home
① Duration = 5s
② Average value = 36 dB
③ Maximum value = 57 dB
④ Minimum value = 13 dB
5. Eating dinner time
① Duration = 5s
② Average value = 21 dB
③ Maximum value = 64 dB
④ Minimum value = 12 dB

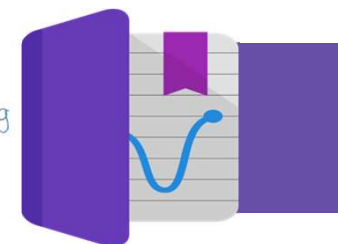
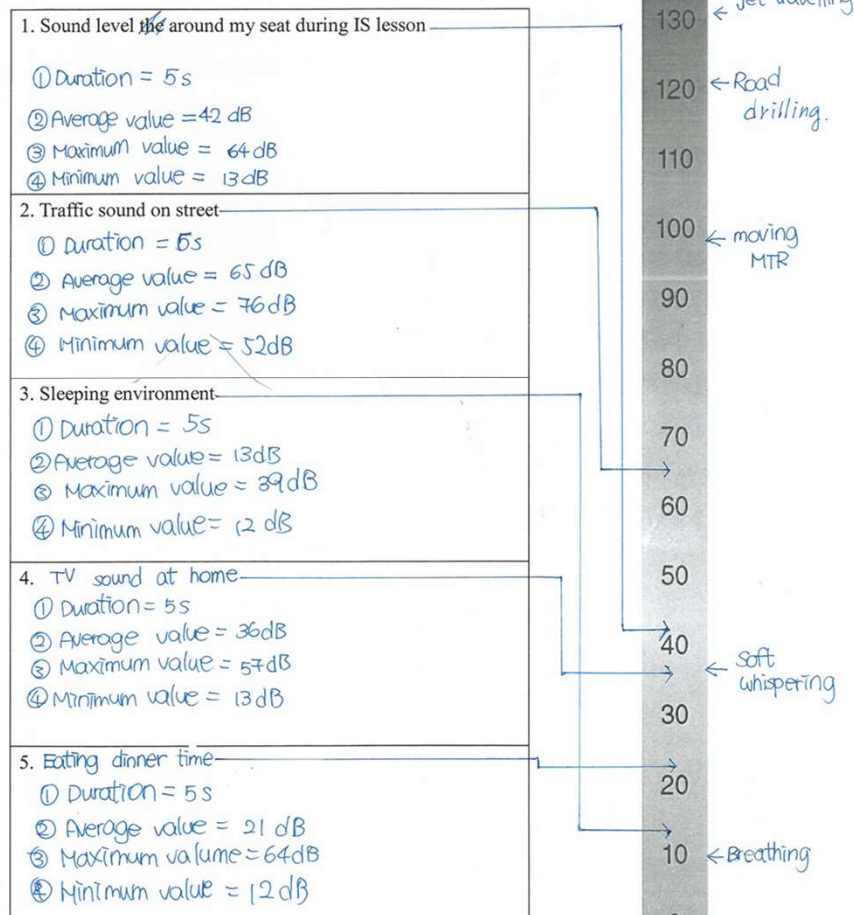
Sound level (dB)



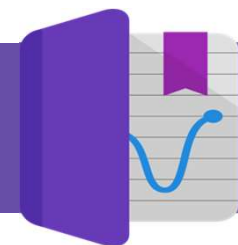
教學分享1 聲音強度

Activity 1

Sound is always surrounding us. Choose 5 daily events that you experience different sound levels. Using the mobile app "Science journal" to measure the sound level of that event for at least 5 seconds and record the results below.



教學分享1 聲音強度 Sound Intensity (dB 分貝)



生活應用



探究睡眠環境聲音強度與睡眠質素的關係



比較不同環境的聲音強度

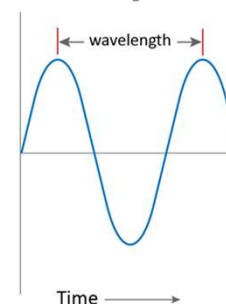


教學分享2 聲音音高Pitch (Hz)

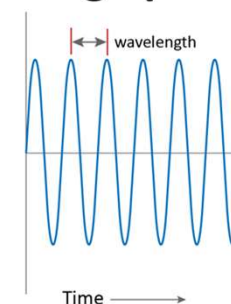
- **量度:** 音訊感應器或麥克風接收到聲音的**頻率 (Frequency)**
- **原理:** 音高是指聲波的頻率，即物體**振動的速率**，振動得越快，音高越高。
手機麥克風接收音訊音高原理與量度強度原理相同。(Faraday's law)
- **手機應用:** 語音輸入法，通話，錄音



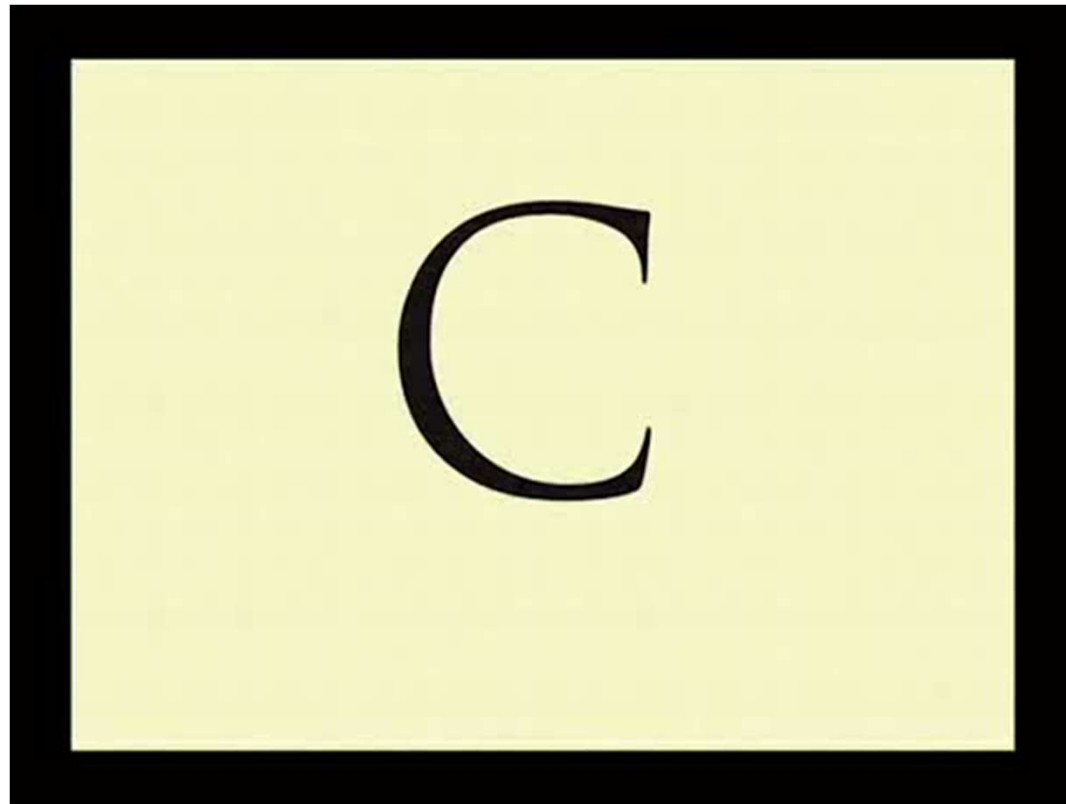
Low pitch



High pitch



Let's Try



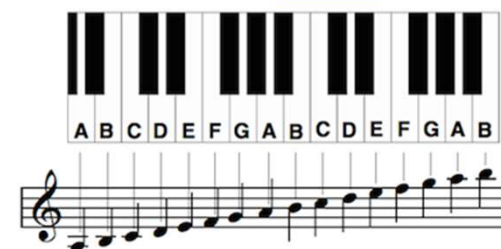
教學分享2 聲音音高Pitch (Hz)

教學內容

S2 IS Sensing the environment

活動內容

- 量度自己的音域 (**Range**)
- 記錄自己唱一段高音及一段低音的歌，長度為10秒
- 在圖表中找出自己最高及最低的音頻
- 回校後比較哪位同學的音域最闊



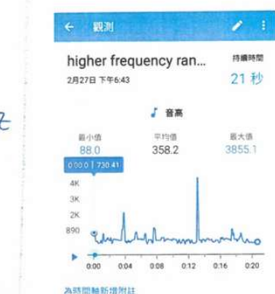
教學分享2 聲音音高(Hz)



Sing a song with at least 10 seconds and use the mobile app “Science journal” to measure the pitch of the song. Capture the screen of the graph and print it out. Stick your work in below table.

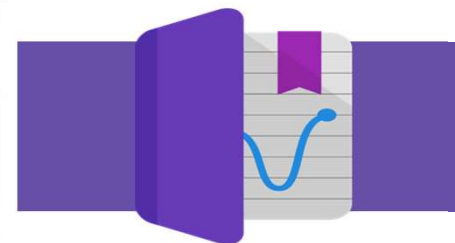
Song 1 with higher frequency range (Hz)

- ① Duration: 21 s
- ② Average value: 358.2 Hz
- ③ Maximum value: 3855.1 Hz
- ④ Minimum value: 88.0 Hz

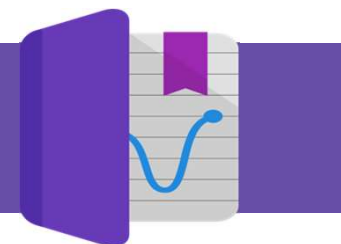


Song 2 with lower frequency range

- ① Duration: 11 s
- ② Average value: 256.0 Hz
- ③ Maximum value: 934.0 Hz
- ④ Minimum value: 0.0 Hz



教學分享2 聲音音高Pitch (Hz)



生活應用



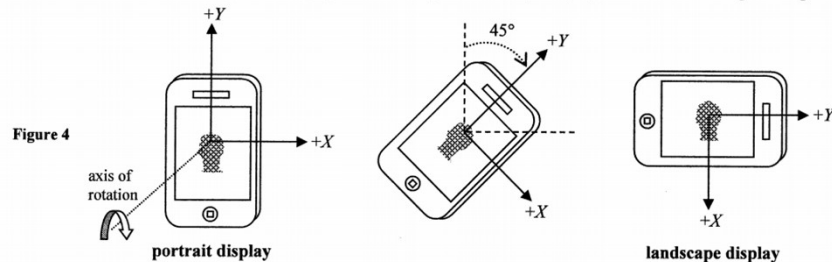
量度音準



教學分享3 加速計 accelerometer (m/s^2)

DSE Physics 2014

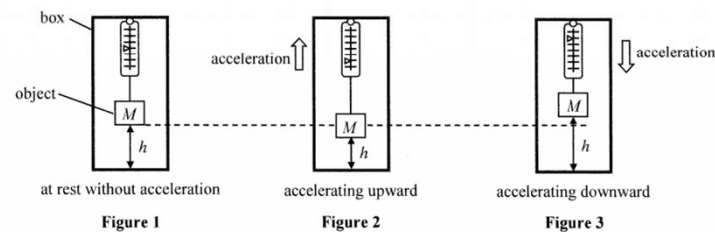
Electronic accelerometers employing similar principles are widely used in smart phones. The phone's orientation is detected by a set of built-in accelerometers each detecting the acceleration due to gravity along mutually perpendicular axes of the phone. A phone in vertical orientation is shown on the left of Figure 4, its accelerometer along the Y axis would be sensing the acceleration due to gravity, denoted by $a_Y = -g$. When the phone is rotated about a horizontal axis perpendicular to both X and Y axes by more than 45° , 'portrait display' would change to 'landscape display' as shown on the right of Figure 4.



- (c) What would the kind of display be if the phone is rotated clockwise until the acceleration a_Y sensed by the accelerometer along the Y axis is $-0.5g$? Explain. (2 marks)

Read the following description about **accelerometers** and answer the questions that follow.

An accelerometer is a device for measuring acceleration. The following example illustrates the principle of a simple accelerometer. An object of mass M is suspended by a spring balance inside a box. If the box is at rest without acceleration, the object is h above the bottom of the box (Figure 1). When the box accelerates upward, h decreases (Figure 2). Likewise, when the box accelerates downward, h increases (Figure 3). Since it is known that the tension of the spring balance is directly proportional to its extension, we can therefore determine the magnitude and direction of the box's acceleration by measuring h .



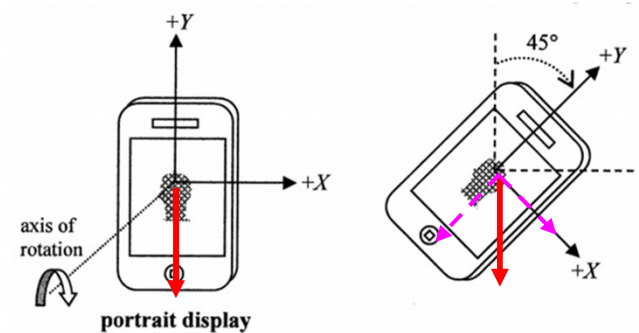
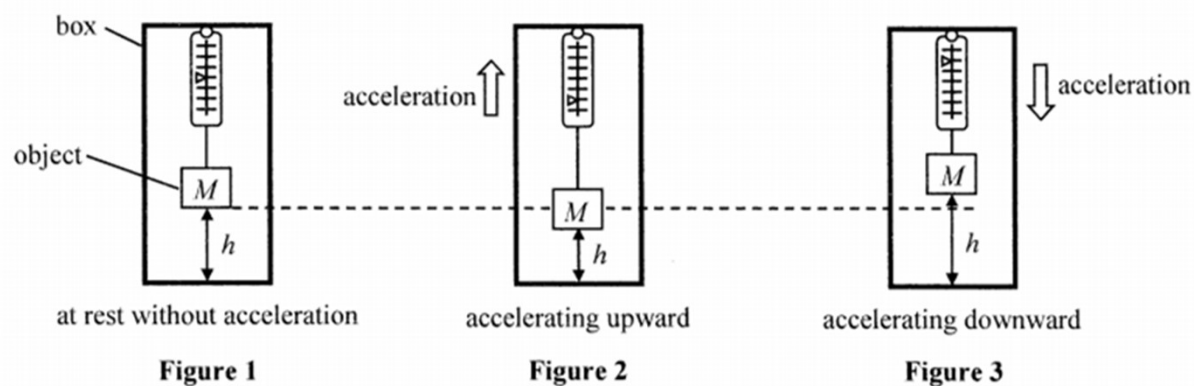
- (a) Draw a labelled free-body diagram in the space provided below showing the forces acting on the object when the box accelerates upward with acceleration a . Explain why h decreases in this case. (4 marks)

acceleration a

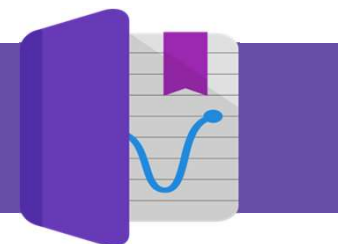


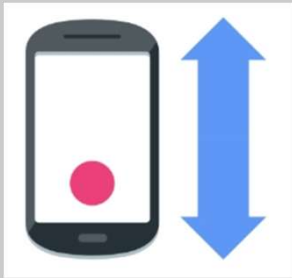
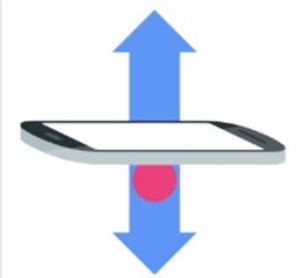
教學分享3 加速計 accelerometer (m/s^2)

DSE Physics 2014



教學分享3 加速計 accelerometer (m/s^2)



總加速率	加速率x	加速率y	加速率z
			
			
已排除重力的影響	須完全平放才可排除重力的影響	須完全平放才可排除重力的影響	完全平放時有重力的影響 $a=9.8\text{ms}^{-2}$

教學分享3 加速計 accelerometer (m/s^2)

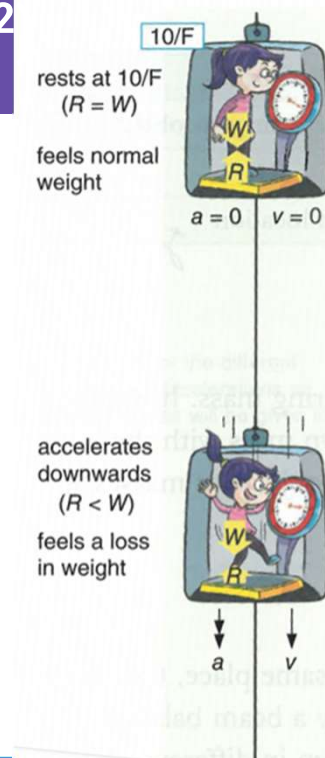
教學內容

S4 Physics Force and Motion(II)

活動內容

量度乘搭升降機時，加速度的變化

1. 靜止
2. 向下加速
3. 向下均速
4. 向下減速
5. 靜止



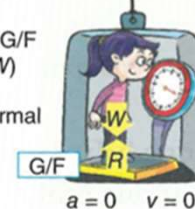
constant velocity ($R = W$)
feels normal weight



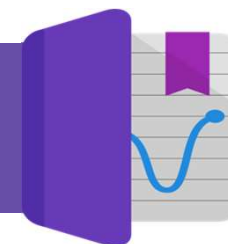
decelerates downwards ($R > W$)
feels a gain in weight



rests at G/F ($R = W$)
feels normal weight



教學分享3 加速計 accelerometer (m/s²)



測試升降機向下降

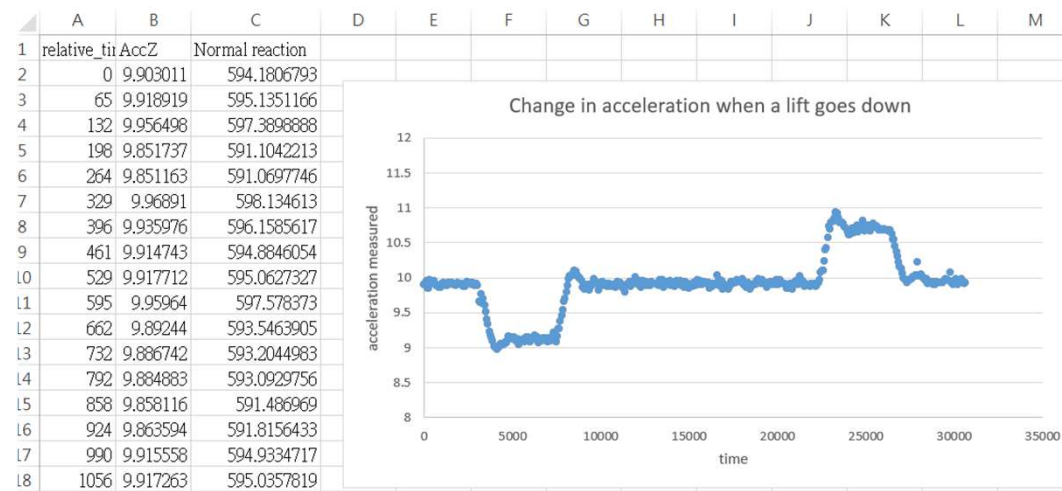
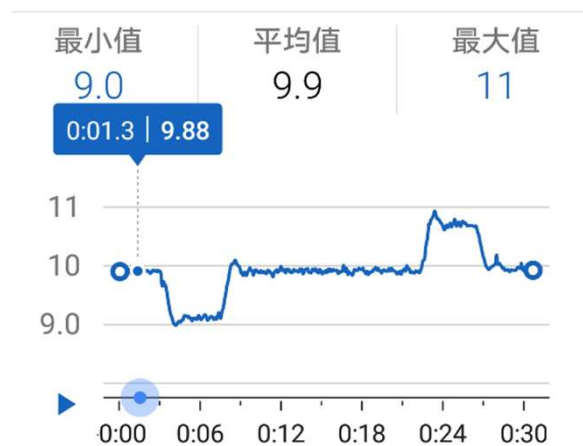
1. 靜止 2. 向下加速

3. 向下均速

4. 向下減速

5. 靜止

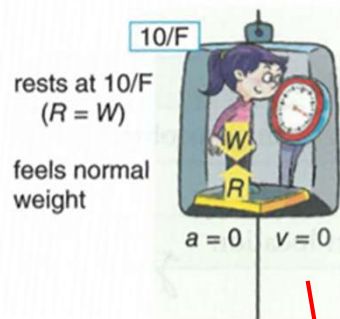
z 加速計 Z



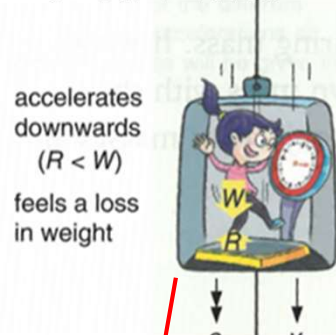
教學分享3 加速計 accelerometer (m/s^2)

1個60kg的人在升降機向下降時的Normal Reaction

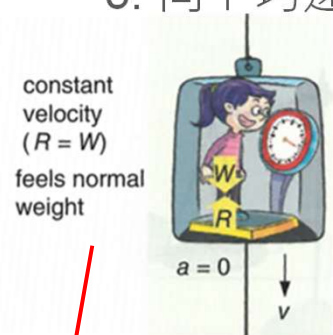
1. 靜止



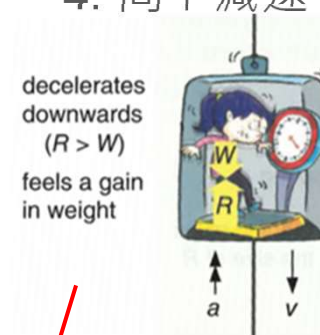
2. 向下加速



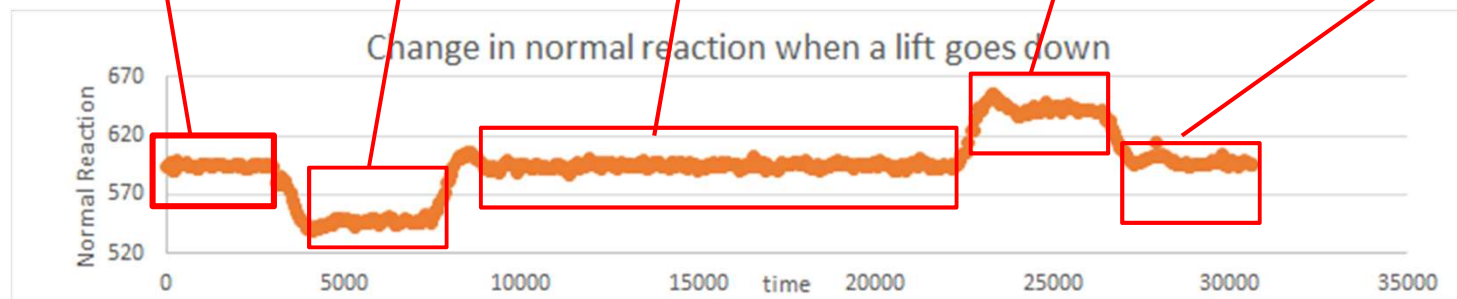
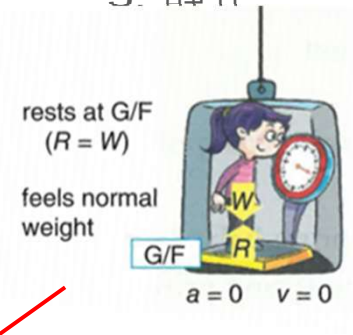
3. 向下均速



4. 向下減速



5. 靜止



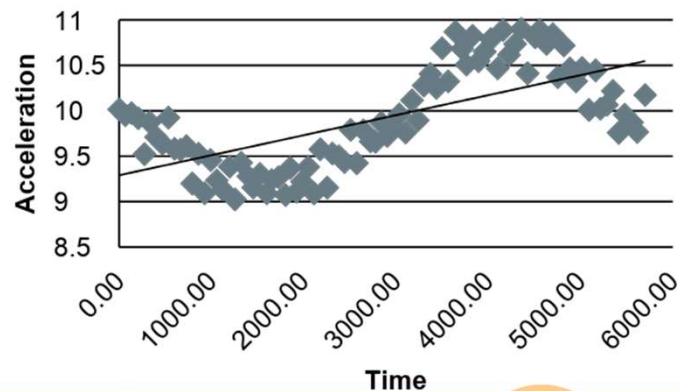
教學分享4 加速度(m/s^2)

測試升降機向下降一層

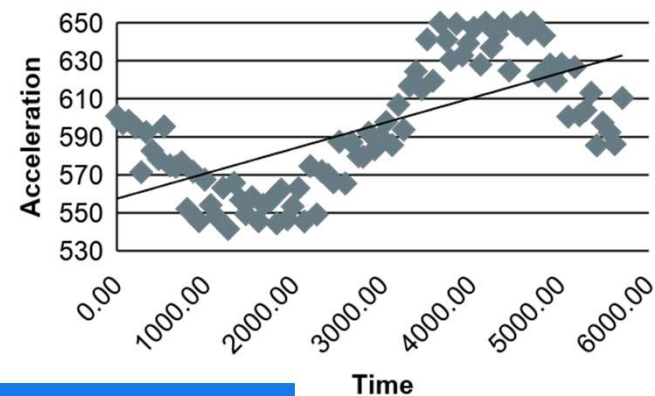
1. 向下加速
2. 向下均速
3. 向下減速



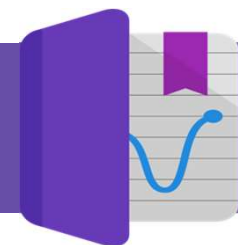
Change in acceleration when a lift goes down



Change in normal reaction when a lift goes down



教學分享3 加速計 **accelerometer** (m/s^2)



生活應用



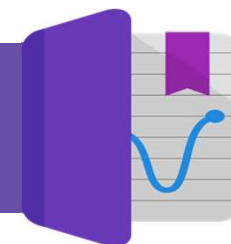
量度睡眠時的動態

量度走路或跑步時
速度的改變

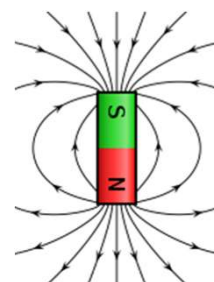


量度行車時的
加速度改變

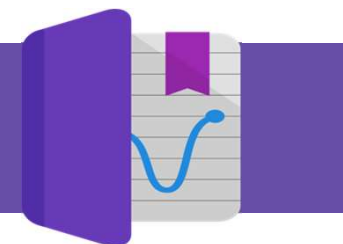
教學分享4 指南針 Compass Sensor (degree)



- 量度: 地球磁場方向
- 原理: 結合磁力儀及加速計的原理
- 手機應用: 指南針
- 容易受磁鐵、電流和金屬物干擾
- 持手機在空中劃數字8，可更準確



教學分享 5 磁力儀 Magnetometer Sensor (μT)



- **量度:** 三維空間的磁場總強度(Magnetic field strength)
- **原理:** 利用磁電阻(magnetoresistance), 即磁場變化會改變電阻, 從而影響電流 (Hall effect)
- **手機應用:** 指南針, 導航
- 容易受磁鐵、電流和金屬物干擾
- 受地球磁場影響, 讀數不會低至零



教學分享6 磁力儀 Magnetometer Sensor (μT)

教學內容

S2 IS, S5 Physics

活動1

- 利用磁石，找出手機中磁力儀的位置

活動2

- 量度線圈中的磁場強度

活動3

- 量度不同電子儀器的磁場強度。
- 例如：耳機

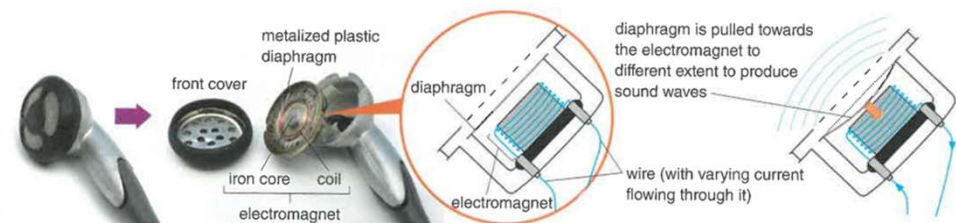
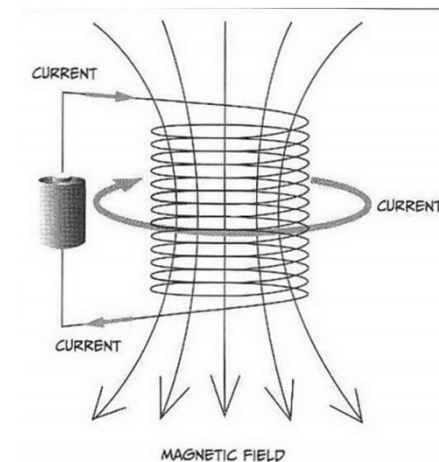
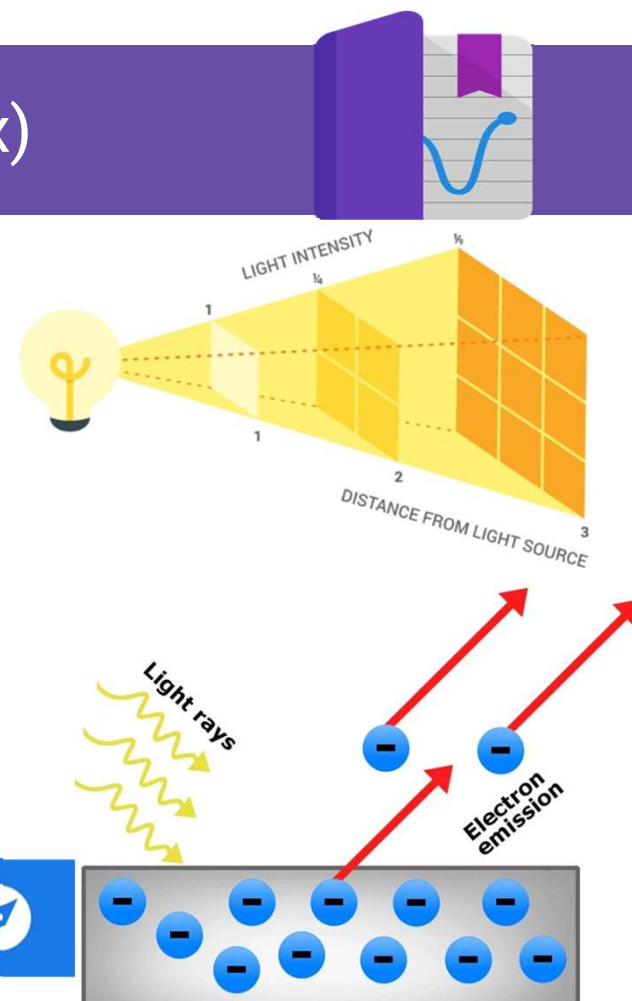


Fig 4.2p Working principle of a earphone.



教學分享7 光度Ambient light (以勒克斯lux)

- **量度:** 量度光線亮度，
- **原理:**
光線亮度是根據光量和光線散佈的區域面積計算而得。
手機中光感測器的微型半導體(Semiconductor)受到光線照射時，會產生微弱的電流。
(Photoelectric Effect)
- **手機應用:** 根據環境光暗程度自動調節螢幕的亮度



教學分享7 光度

教學內容

S2 IS Acid & Alkaline

S4 Chemistry Acid & Base

活動內容

- 酸鹼滴定測試
- $\text{HCl} + \text{NaOH}$
- Phenolphthalein indicator



(a)



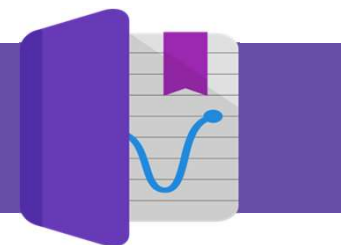
(b)



(c)

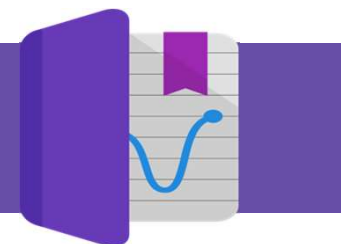


Google Science Journal 的限制



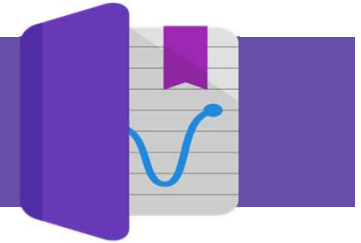
- 不同手機Sensor準確度存有差異
- 只能用同一款手機作比較
- 部份只能用於展示概念比，而非準確運算
- 語言根據手機系統而定，IOS未有繁體版

Google Science Journal 的好處



- 方便於實驗室以外使用，融入生活，更容易相信科學定律
- 增加學生參與度，提升學習動機
- 數據收集頻密，約每0.1秒度一次
- 以數據和圖表展示抽象量值
- 可訓練學生閱讀圖表

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