

PBL: Waves Advanced
活動單元：波浪(干涉、繞射、駐波)
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Names	IDs(3 digit)			Gr

0. Introduction 簡介

在這個單元，你要處理基本電子在三個不同物理學領域的模擬實驗，在你開始作答問題前，玩玩看每個模擬實驗，熟悉每個模擬實驗的操作，並利用這些模擬來回答問題。

In this activity unit, you will perform virtual experiments with public domain physics simulations dealing waves and wave motion. Before you start answering the questions, play with each simulation. Get familiar with each of the different effects and buttons of the animations. Where there are tabs, utilize them.

1. Standing Waves

1.1 下載模擬器 Download, Run and Play with the PhET Simulation: “Wave on a String”.

1.2 [Select: Pulse, Fixed End, Damping (none), Amplitude= 0.75 cm] Observe the wave and draw a pictures. (a) From left to right (b) From right to left (c) Describe how the motion of the string changes with time? 調整振幅為 0.75 公分，觀察並畫下波型。(a)從左至右 (b)從右至左 (c)描述波型的變化，寫下前後有哪些不同

(a) From left to right	(b) From right to left
(c)	

1.3 [Select: Pulse, Loose End, Damping (none), Amplitude= 0.75 cm] Observe the wave and draw a pictures. (a) From left to right (b) From right to left (c) Describe how the motion of the string changes with time? 調整振幅為 0.75 公分，觀察並畫下波型。(a)從左至右 (b)從右至左 (c)描述波型的變化，寫下前後有哪些不同

(a) From left to right	(b) From right to left
(c)	

1.4 [Select: Oscillate, Fixed End, Damping (none), Frequency (f) = 3 Hz] Observe the wave and draw a pictures. (a)At the very beginning (b) After a long time (c) Describe how the motion of the string changes with time? (d) Try to explain why the wave changes. 調整頻率為 3 赫茲,觀察並畫下波型。(a)一開始 (b)經過一段時間 (c)寫下經過一段時間運動後的波型和一開始的差異 (d)解釋波為何發生變化

(a) At the very beginning	(b) After a long time
(c)	
(d)	

1.5 [Select: Oscillate, Loose End, Damping (none), Frequency (f) = 3 Hz] Observe the wave and draw a pictures. ((a)At the very beginning (b) After a long time (c) Describe how the motion of the string changes with time? (d) Try to explain why the wave changes.調整頻率為 3 赫茲，觀察並畫下波型。(a)一開始 (b)持續一段時間後 (c)寫下經過一段時間運動後的波型和一開始的差異 (d)解釋波為何發生變化

(a) At the very beginning	(b) After a long time
(c)	
(d)	

1.6 Compare the Fixed end and the Loose end. Comment the differences and similarities between the two. i.e. consider amplitude (A), wavelength (λ), frequency (f) and the same point. 比較固定端和鬆弛端相同與相異，寫下相同處和相異處，例如:振幅、波長、頻率、同一個點的變化

Similar:
Different:

1.7 Find a frequency so that the point in the center of the string does not move after the initial transient behaviour (a) Fixed end (b) Loose end (c) Try to summarize an equation the relationship between frequency and length of the string. 找出一個頻率可以讓繩子最中心點不會移動(a)固定端 (b)自由端 (c) 試著寫出一個和頻率以及繩長的關係式

(a) $f = \underline{\quad}$ Hz; $f = \underline{\quad}$ Hz	(b) $f = \underline{\quad}$ Hz $f = \underline{\quad}$ Hz
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(c)

2. Wave interference

2.1 下載模擬器 Download, Run and Play with the PhET Simulation: “Wave interference” [Tab: Interference]

2.2 [Select: Water] (a) Open one faucets Draw what you see. 將兩個水龍頭打開，觀察並畫下波型。(b) Open the second faucet. Draw what you see. (c) What is the reason make the gray line when you have 2 sources? 現在你可以看到兩波中間有兩條灰色的線，寫下產生灰線的原因。

(a)

(b)

(c)

2.3 [Select: Water] Observe the effect of frequency on the picture. Draw it. (a) lowest frequency drip (b) highest frequency drip 改變頻率並畫下波形。(c) How do the images change with frequency? 為甚麼改變頻率會影響波。

(a) Low frequency drip

(b) High frequency drip

(c)

2.4 [Select: Sound, both(wave and particles)] Choose a red particle to observe. When one speakers is on, the particles will move . (a) How do the particles move? (b) Why do they move that way?. 找一個紅色粒子觀察，當一個喇叭打開時，紅色粒子會開始移動 (a)寫下它會怎麼移動 (b)為甚麼?

(a)

(b)

2.5 [Select: Sound, both(wave and particles)] Now open two speakers. Does the red particle move by differently? 現在打開兩個喇叭，請問紅色粒子移動方式有改變嗎?

2.6 [Select: Light, Screen] Compare images formed on the screen by red and blue light. 選擇紅光和藍光並寫出兩者在屏幕上的不同。

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2.7 [Select: Light, Screen] What is the effect of changing the separation between sources on the image seen on the screen?. 如果更改兩雷射的間距，那屏幕上的亮暗紋會發生甚麼變化？

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3. Wave Diffraction

3.1 下載模擬器 Download, Run and Play with the PhET Simulation: "Wave interference" [Tab: Diffraction]

3.2 [Select: circle hole, square hole] Turn on the laser light. Observe the patterns formed the screen. Draw (Make sure you add a scale bar) for the (a) circular hole and the (b) square hole. (c) What is different? 打開雷射光觀察屏幕上的成像，畫下圖形(a)圓孔 (b)方形孔 (c)寫下不同的地方（確保在圖中放置了比例尺）

(a) circular hole Size of hole: ___ mm	(b) square hole Size of hole: _____ mm
(c)	

3.3 [Select: circle hole] Change the diameter of the hole. (a) Draw (Make sure you add a scale bar) the diffraction pattern. (b) Summarize the effect in words, 改變圓孔的半徑 (a)畫圖 (b)寫出屏幕成像的變化（確保在圖中放置了比例尺）

(a) Size of hole: ___ mm	(b)

3.4 [Select: circle hole] Change the Wavelength. (a) Draw the diffraction pattern. (b) Summarize the effect in words, 改變光的波長 (a)畫圖 (b)寫出屏幕成像的變化

(a) $\lambda =$ _____ nm	(b)

3.5 [Select: square hole] Change the rectangular hole into a slit. (a) Draw the diffraction pattern. (b) Summarize the effect in words, 改變方形孔將它縮為狹縫 (a)畫圖 (b)寫出屏幕成像的變化

(a) $\lambda =$ _____ nm $L =$ _____ mm $W =$ _____ mm	(b)
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3.6 Reset the simulation. Compare the image formed by a single circular hole and a matrix of circular holes, and (a) Draw the picture of the single hole (b) Draw the image of the matrix of holes (c) Comment on the differences and similarities. 將模擬重置，比較單一圓孔和矩陣圓孔的成像，畫下圖形(a)單一圓孔 (b)矩陣圓孔 (c)寫下不同和相同的地方

(a) circular hole	(b) matrix of circular holes
(c)	

4. 您的意見 Student Comments

4.1 Did you enjoy the activity? 你喜歡這個活動嗎？

- LOVED 喜愛
- 75%
- 馬馬虎虎
- 25%
- HATED 憎恨

Why? 為什麼？

4.2 提出 1 或 2 個問題 可以 添加到本題目簿 如果你的問題被使用，加 1 分！（最多加 5 分） Suggest one or two additional questions that could be asked concerning any of the simulations you played with. (If we add your question, you will get 1% bonus marks for the course!)

Activity	Suggested Question	Answer to suggested question

4.3 有沒有別的意見？ Any other suggestions to improve this activity?

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