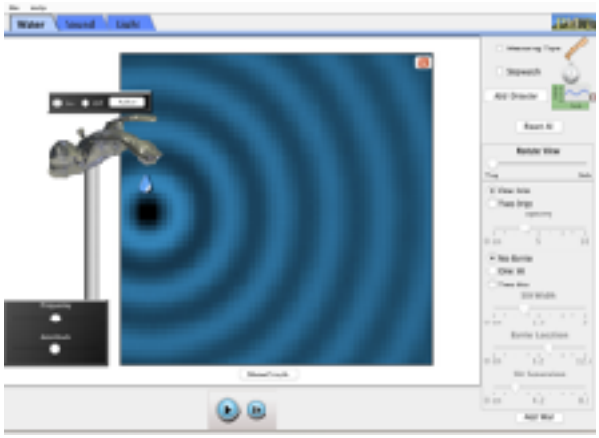
Wave Interference Path Difference

In this activity students will be exploring path difference in the determination of antinodes and nodes with light using the “Wave Interference” PhET simulation.

Open the simulation by clicking on the link:

https://phet.colorado.edu/en/simulation/legacy/wave-interference

Take a look at the explanatory video via YouTube:
https://youtu.be/DjUaUNC33Bc



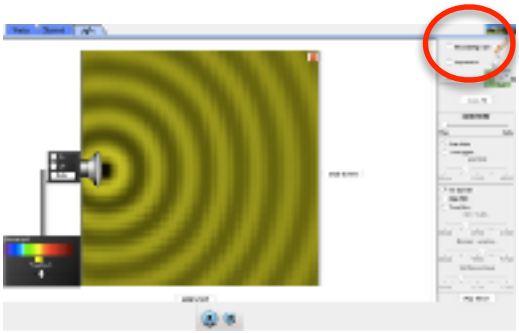
Learning Objectives

By the end of these activities it is hoped that students will have an acquired the following skills:

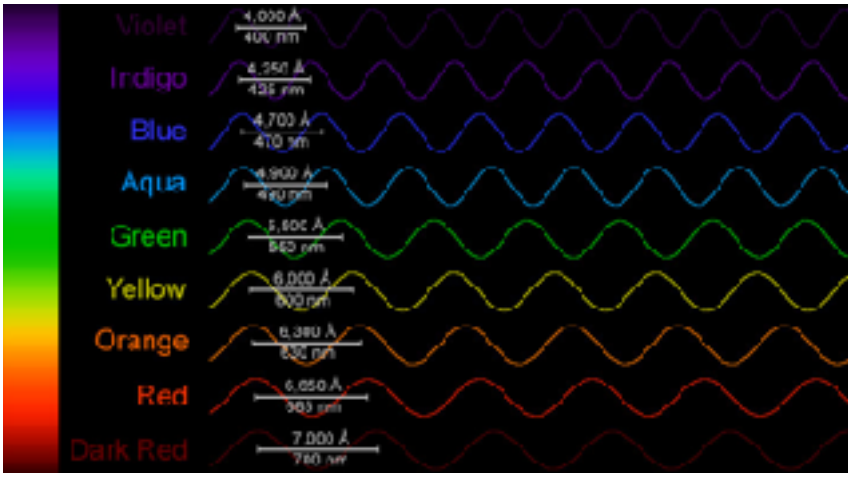
- Following explicit instructions to gain acquired knowledge
- Use the simulation to measure path difference between two sources and a point on the interference pattern.
- Come up with a relationship between path difference, wavelength and antinode/nodes.

Author: Simon Lees 2017

Activity A: Determining the wavelength of light



- Click on the light tab at the top of the simulation.
- In the bottom of the left hand corner is the wavelength spectrum. Move the arrow and determine a specific colour.
- Click on the measuring tape selector shown by the red circle.
- Measure the wavelength from crest to crest or thought to trough. This will be in “nm”. (1nm = 1 x 10^{-9}m)
- **Wavelength of your chosen light?**



https://www.windows2universe.org/physical_science/magnetism/images/visible_spectrum_waves_big.jpg

Find your wavelength colour on the chart above. The difference between the acquired value and the value shown here will roughly be your error. Use this to determine further wavelength issues later on.

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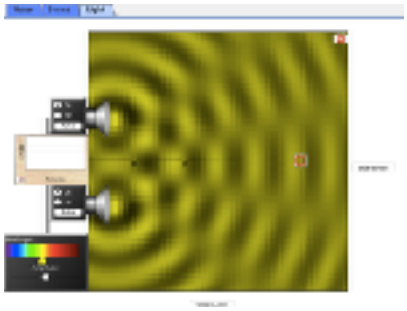
Activity B: Determining path difference for antinodes



- Now place two light sources on the screen.
- Select the "**Add Detector**" button and place it between two light sources as shown in the image opposite. Extend the cross hairs so they run a long the middle of the first antinode. Check that the maximum amplitude is achieved at this point by turning ON and monitoring the detector trace.
- Now select tape measure and place one end in the middle of the bottom light source and extend the other so it fits between the crosshairs of the detector. Note down the length in **table 1**.
- Now do exactly the same but from the top light source to the crosshairs on the detector and place length in **table 1**.

Table 1:

Distance from…….	Distance (nm)
Bottom lamp to crosshairs	
Top lamp to crosshairs	
Path difference	

- **Take the two distances from the lamps away from each other and place the answer in the bottom row. Ignore any negative value this only shows it is either above or below the centre line.**
- **What can you say about this value?**

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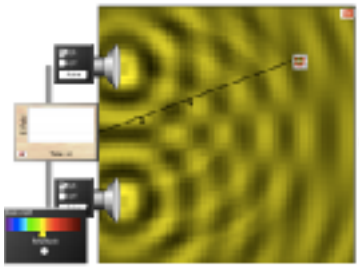
- **The path difference for this point should be 0, explain why your value is different if it is at all?**

- Now move the detector to the centre of the next antinode either up or down, as shown in the image opposite. Check that the maximum amplitude is achieved at this point by turning ON and monitoring the detector trace.



- Now measure to the crosshairs from the centre of each of the lamps and place the values in **table 2**.

Table 2:

Distance from…….	Distance (nm)
Bottom lamp to crosshairs	
Top lamp to crosshairs	
Path difference	

- **Take the two distances from the lamps away from each other and place the answer in the bottom row. Ignore any negative value this only shows it is either above or below the centre line.**
- **Now compare this value to the value acquired for the wavelength of the light found in Activity A. What do you notice?**

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- The path difference between these two points should equate approximately to one whole wavelength thus this antinode is given the order of “1”.
- **Predict what the path difference would be for an antinode of order 3 based on the approximate wavelength value for your colour.**

- **Using this information come up with a relationship between path difference and wavelength for antinodes.**

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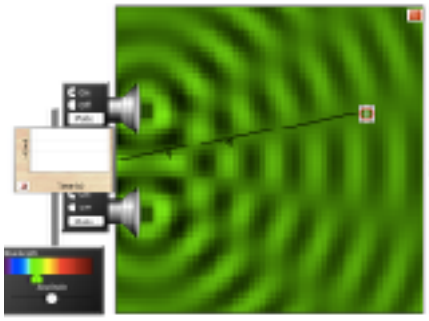
Activity C: Determining path difference for nodes

- Now place two light sources on the screen.
- Select the "**Add Detector**" button and place it between two light sources as shown in the image opposite. Extend the cross hairs so they run a long the first nodal line as shown in the diagram opposite.



- Now select tape measure and place one end in the middle of the bottom light source and extend the other so it fits between the crosshairs of the detector. Note down the length in **table 3**.
- Now do exactly the same but from the top light source to the crosshairs on the detector and place length in **table 3**.

Table 3:

Distance from…….	Distance (nm)
Bottom lamp to crosshairs	
Top lamp to crosshairs	
Path difference	

- **Take the two distances from the lamps away from each other and place the answer in the bottom row. Ignore any negative value this only shows whether it is either above or below the centre line.**
- **Now compare this value to the value acquired for the wavelength of the light found in Activity A. What do you notice?**

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- The path difference between these two points should equate approximately to half a wavelength.
- **Predict what the path difference would be for 2nd node based on the approximate wavelength value for your colour.**

- **Using this information come up with a relationship between path difference and wavelength for antinodes.**

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SUMMARY:

- **What is the relationship between path difference and wavelength for antinodes?**

- **What is the relationship between path difference and wavelength for nodes?**