Light Behaves like a Wave

Wave Optics - Download and run the PhET simulation *Wave Interference*. (https://phet.colorado.edu/en/simulation/wave-interference) Take several minutes to familiarize yourself with the simulation. Play with the different modules (Water, Sound, Light) and get to know the different tools you have available within each module. Reset everything before you begin the other parts of this activity. You may find it helpful to increase the size of the simulation's viewing window by clicking on the small box with a '+' in the upper right-hand corner.

1: Water Waves

1.) How does changing the frequency of the drip (disturbance) affect the characteristics of the water waves?

2.) How does changing the amplitude of the drip affect the characteristics of the water waves?

3.) Sketch the water waves from both the top and side views. Label the wavelength of the wave in each of your sketches.

Top: **Side:**

4.) How does the wavelength of the wave depend upon the frequency of the wave? How were you able to come to this conclusion?

5.) Come up with a method to determine the speed of a water wave. Outline your procedure and share your results below. You may want to consider running several trials and averaging your results.

6.) How does changing the frequency of the drip affect the speed of the waves?

7.) What effect does changing the amplitude of the drip have on the speed of the waves?

8.) How does amplitude change with distance from the disturbance? How could you tell? What might be causing this to happen?

9.) What do you think would happen to the waves if a barrier with a narrow slit (aperture) were placed in the path of the wave? Draw your prediction as viewed from above (Top) in the space below. Then test your prediction and comment on how closely your prediction matched what you observed.

10.) As waves pass through an appropriately-sized aperture they can spread out, or *diffract*; something you just observed. Predict what would happen if you increased the size of the aperture. Would the waves diffract more or less? Make a sketch of your prediction in the space below. Then test your prediction and comment on your observations.

2: Sound Waves

1.) Using the method you developed in the previous activity, measure the speed of a sound wave. Compare this with the 'accepted' value of the speed of sound (you may need to go online or elsewhere to find this value). What might be some reasons for any discrepancies between your calculated value and the accepted value?

2.) How does the sound intensity (amplitude or 'volume') change as the distance between the source of the sound wave and the observer increases? How could you tell? What might be causing this to happen?

3: Light Waves

1.) Use the simulation to determine the wavelengths of the following colors of light:

Red:
Orange:
Yellow:
Green:
Blue:
Violet:

2.) Using the method you developed in the previous activities, determine the speed of a light wave. Does this speed depend on the frequency of light? Amplitude? Compare this with the 'accepted' value of the speed of light (you may need to go online or elsewhere to find this value). What might be some reasons for any discrepancies between your calculated value and the accepted value?

3.) You saw in the previous activity, that waves can diffract when they interact with an appropriately-sized aperture. Light, being a wave, is capable of doing the same thing. Using the space below, sketch what you predict the pattern would look like on a screen placed in the path of a light wave if:

Light hits screen unobstructed without passing through aperture:

Light hits screen after passing through a single narrow aperture (single slit):

Light hits screen after passing through two, closely-spaced, narrow apertures (double slit):

4.) Test your predictions and comment on how closely your predictions matched your observations.

5.) You just saw that the pattern of light after passing through a double-slit resembles a series of closely-separated bands of light, known as an *interference pattern*. In the space below, predict what you think would happen to the interference pattern if the following parameters were adjusted independently:

Wavelength of light (λ):

Distance between barrier and light source (*L*):

Distance between slits (*d*):

6.) Test your predictions and comment on how closely your predictions matched your observations.

7.) Using what you just observed, come up with three relationships (proportionalities) describing how the positions of the bright fringes (*y* – the distances from the central maximum) depend on λ, *L*, and *d*. Combine these proportionalities into a single equation.

8.) Use your new equation to solve the following problem (Knight – 17.8): Light from a sodium lamp (λ = 589 nm) illuminates two narrow slits. The fringe spacing on a screen 150 cm behind the slits is 4.0 mm. What is the spacing (in mm) between the two slits?