Wave Interference

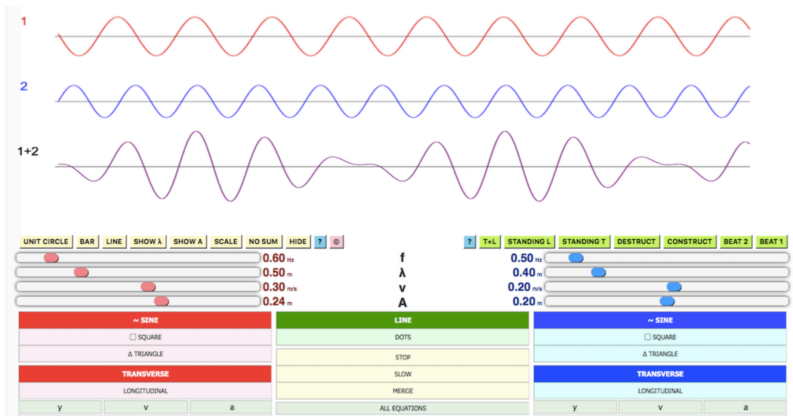
Purpose: To investigate details regarding the interference of two waves traveling through the same medium.

Getting Ready: Navigate to the **Wave Addition** simulation found in the **Physics Interactives** section of **The Physics Classroom**.

https://www.physicsclassroom.com/Physics-Interactives/Waves-and-Sound/ Wave-Addition

Navigation:
www.physicsclassroom.com => Physics Interactives => Waves and Sound => Wave Addition

Getting Acquainted:



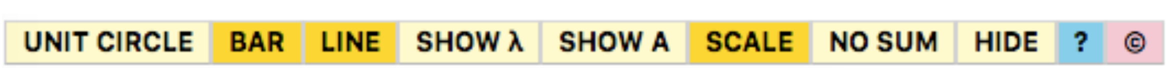
The Wave Addition Interactive displays two animated waves – Wave 1 (Red) and Wave 2 (Blue) – and the *Wave Sum* (1 + 2) at the top of the simulation window. The controls and buttons are located at the bottom of the simulation window.

Before you begin this activity, get acquainted with how it works by *playing with* the various buttons and slider controls. Tap a button or drag a slider and observe how the waves change or how the wave display changes. Don't worry about *ruining* anything. You can always reload the page to reset the simulation to its original state. Your goal is to get acquainted with the interface and to do a bit of exploring of waves. Be sure to learn how to adjust the various wave properties of both Wave 1 (Red) and Wave 2 (Blue). These properties include frequency (**f**), wavelength (**l**), velocity or speed (**v**), and wavelength (**λ**). Learn how to stop and start the simulation, how to display a Dot, a Line, and an Amplitude Bar for the waves, and how to change the wave from a transverse wave to a longitudinal wave.

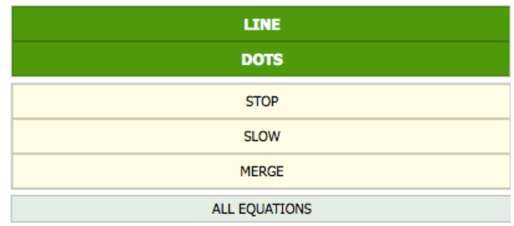
Procedure and Questions:

1. Once you have done some exploring as described in the **Getting Ready** section, you are ready to study **Wave Interference**. Tap on the Destruct button in the top row of the Control Panel.

Then tap on the **Bar**, the **Line**, and the **Scale** button.



Finally, tap on the **Line** and the **Dots** buttons so that the wave is represented by a collection of dots and connecting lines. The dots can be thought of as the particles of the medium. For instance, you could think of each dot as representing each coil of a Slinky or as a very small section of a vibrating rope.

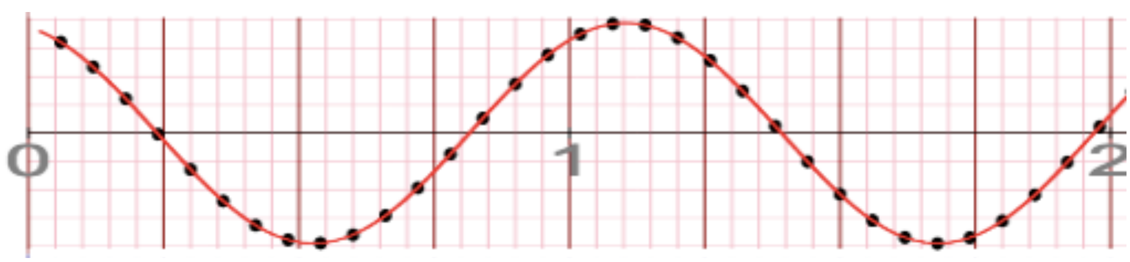


2. Run the simulation so that Wave 1 and Wave 2 are moving. Observe the **Wave Sum** (labeled **1 + 2**). Describe the displacement of each individual dot for the **Wave Sum**.

3. **Interference** is the meeting up of two waves that are traveling through the same medium. This form of interference that is occurring at each location is known as **Destructive Interference**. Stop the simulation so that you can answer the following question.

   Destructive interference will occur at any location where …
   a. each individual wave is stationary.
   b. the displacement of particles for both waves is in the same direction (e.g., both up).
   c. the displacement of particles for one wave is upward and the other is downward.

4. Consider the wave below. We will call it **Wave 1**. Sketch what **Wave 2** must look like in order for it to interfere with Wave 1 such that destructive interference occurs <u>for every particle</u> along the length of the 2-meter long medium.



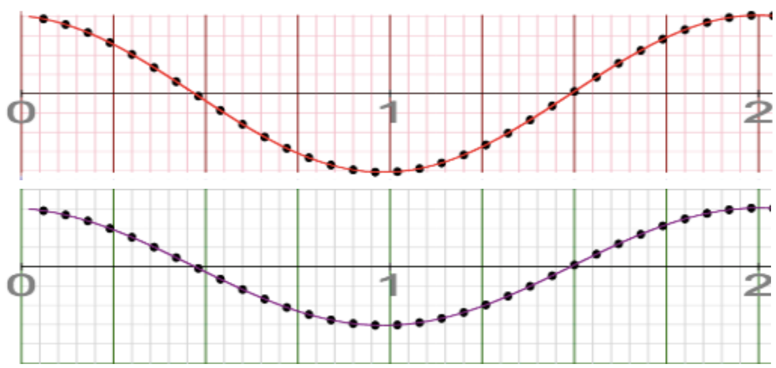
5. Tap on the **Construct** button in order to view an example of **constructive interference**. Describe how the **Wave Sum** for a constructive interference situation is different than destructive interference.

6. **Stop** the simulation and analyze any of the points along the medium in order to answer this:

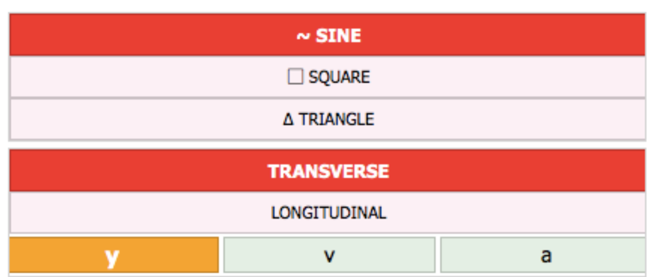
   Constructive interference will occur at any location where …
   a. each individual wave is stationary.
   b. the displacement of particles for both waves is in the same direction (e.g., both up).
   c. the displacement of particles for one wave is upward and the other is downward.

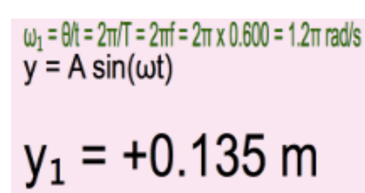
7. So far we've seen situations in which **Wave 1** and **Wave 2** have the same amplitude. But constructive and destructive interference is not limited to situations in which each wave has the same amplitude. Tap on the **Destruct** button again. Observe the **Wave Sum**. Then change the amplitude of **Wave 1** to 0.16 m; keep the amplitude of **Wave 2** at 0.32 m. This is also an example of **destructive interference**. Observe the **Wave Sum**. Describe how it is different than a situation in which two waves have the same amplitude (as in **Question 2**).

8. The diagrams at the right shows **Wave 1** (top) and the **Wave Sum** (bottom). On the top diagram, <u>sketch what you think **Wave 2** must look like</u> in order for the sum of the two waves to look like the bottom pattern. Experiment with the simulation if you need to.



9. The shape of the **Wave Sum** – sometimes called the **Resultant Wave** – can be predicted from a knowledge of the displacement of each individual particle along the medium for each of the two combining waves. We are going to try to discover the rule that allows one to predict the shape. Begin by making sure the **Bar**, **Line**, and **Scale** options are still selected. Then give Wave 1 and Wave 2 <u>the same speeds but different frequencies, wavelengths, and amplitude</u>. Finally, tap on the **y** button in the **Equations** section of the Control Panel; do this for each wave. Observe that the y-displacement of the particles are displayed in the simulation window (see diagram at right). Moving your mouse along the medium will produce different displacement values for different points.





Stop the simulation and use the y-equation boxes to retrieve values for the y-displacement of **Wave 1**, **Wave 2**, and the **Wave Sum** at the four different locations along the medium.

Location	**Y_1 (m)**	**Y_2 (m)**	**Y_{SUM} (m)**
1.0-m Mark			
1.5-m Mark			
2.0-m Mark			
3.0-m Mark			

10. Make a claim regarding the relationship between Y_1, Y_2, and Y_{SUM}. Support your claim with some evidence and reasoning.

11. The relationship you (hopefully) discovered in Question #9 and #10 is called the **Principle of Superposition**. The diagram below shows **Wave 1** and **Wave 2**. Use this principle to determine the displacement of the **resultant** (Wave Sum) for the provided dots. Then draw the resultant wave.