

### Water Screen

Make waves with a dripping faucet. Adjust frequency and amplitude, and observe the effects.

**GENERATE**  
continuous wave  
or pulse

**VIEW** wave from  
the top or side

**ADJUST**  
frequency and  
amplitude

**MEASURE**  
wavelength or  
speed

**ACCESS** sim  
features (sound  
on/off, keyboard  
shortcuts)

### Sound Screen

Use a speaker to create a sound wave. Observe the sound wave as particles, waves, or both.

**OBSERVE** the  
distance and time  
scale

**COMPARE**  
amplitude and  
phase

**HEAR** the sound  
generated by the  
speaker

**SEE** particle or  
wave view of

## Light Screen

Experiment with a laser and discover what determines the color of light.

**GRAPH** the electric field at the mid-line

**PAUSE** and **STEP** through frame-by-frame

**EXPERIMENT** with the color of light

**HEAR** the changes to the light frequency and amplitude

**OBSERVE** the apparent color on the screen

## Model Simplifications

- The color of the wave maps to its amplitude (fully saturated color = peak at max amplitude; fully saturated black = trough at max amplitude). The color-mapping is piecewise defined. Amplitudes greater than zero linearly map to color values of 40%-100%, while amplitudes less than zero linearly map to color values of 0%-40%. This was done to improve the appearance of the nodes in the [Wave Interference](#) sim, while maintaining balance between the apparent widths of the maxima and minima.
- Before the laser is turned on, the wave viewing window is black, suggesting that the light propagates into vacuum. However, when the laser is running, black represents a trough.
- Due to the different time scales across the water, sound, and light screens, the next frame button will advance time by a different amount in each screen.
- The boundaries of the wave viewing window are absorbing, but there are still some artifacts due to internal reflections. This can result in some noise in the Screen.
- The particle view of sound can only support one frequency at a time. Changing the frequency will lead to temporary misalignment between the particles and the wavefronts at the previous frequency.

## Suggestions for Use

### Sample Challenge Prompts

- Compare water, sound, and light waves. What similarities and differences do you notice?
- How does changing the frequency and amplitude affect the characteristics of the wave? How are the water droplet and speaker affected?
- Design an experiment to measure the speed of the wave. How does your measurement compare to the accepted value of the speed of sound or light? How can you explain the discrepancies between your calculated value and the accepted value?

## Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '?' to the sim URL, and separating each query parameter with an '&'. The general URL pattern is:

```
...html?queryParameter1&queryParameter2&queryParameter3
```

For example, in Waves Intro, if you only want to include the 1st and 2nd screens (`screens=1,2`), with the 2nd screen open by default (`initialScreen=2`) use:

[https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro\\_all.html?screens=1,2&initialScreen=2](https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_all.html?screens=1,2&initialScreen=2)

To run this in Spanish (`locale=es`), the URL would become:

[https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro\\_all.html?locale=es&screens=1,2&initialScreen=2](https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_all.html?locale=es&screens=1,2&initialScreen=2)

Query Parameter and Description	Example Links
<code>screens</code> - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the <a href="#">Help Center</a> .	<code>screens=1</code> <code>screens=2,1</code>
<code>initialScreen</code> - opens the sim directly to the specified screen, bypassing the home screen.	<code>initialScreen=1</code> <code>initialScreen=3</code>
<code>locale</code> - specify the language of the simulation using <a href="#">ISO 639-1</a> codes. Available locales can be found on the simulation page on the <a href="#">Translations tab</a> . Note: this only works if the simulation URL ends in "_all.html".	<code>locale=es</code> (Spanish) <code>locale=fr</code> (French)
<code>audio</code> - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	<code>sound=muted</code> <code>sound=disabled</code>
<code>allowLinks</code> - when <code>false</code> , disables links that take students to an external URL. Default is <code>true</code> .	<code>allowLinks=false</code>
<code>supportsPanAndZoom</code> - when <code>false</code> , disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is <code>true</code> .	<code>supportsPanAndZoom=false</code>

## Inclusive Features

### Sound and Sonification

- The Wave Meter tool, available on all screens of the simulation to track wave properties over time, plays an instrumental note that changes in change in pitch. It changes from a high pitch as the wave reaches its peak to a low pitch as it reaches a valley. You'll also hear a decrease in volume as the amplitude of the wave decreases. The second sensor behaves the same, but with a slightly different instrumental voice.

- *Water Screen*: A sound plays as the water droplet hits the surface that changes in pitch as the size of the droplet changes with the change in Amplitude slider. A change in frequency can also be tracked while listening to the droplet.
- *Sound Screen*: Turning on the speaker plays a tone that oscillates in volume emphasized the peak of the wave and changes in pitch with a change in frequency. The changes can be further emphasized by enabling the "Play Tone" checkbox.
- *Light Screen*: The amplitude and frequency effects can be emphasized by enabling the "Sound Effect" checkbox, changing the volume with the amplitude of the light wave and pitch with the frequency (or color) of the light wave.
- See the Sound Features Video for more useful tips on how concepts and sound are integrated in this sim. For additional details on all sounds used in this simulation, see the published [Sound Design Documentation](#).

See the simulation page for all supported inclusive features.

See all published activities for Wave Intro [here](#).

For more tips on using PhET sims with your students, see [Tips for Using PhET](#).

By the end of this worksheet, I understand:

- the behaviour of the waves in water from the side view and the top view
- the wavelength, frequency, amplitude of the water waves.

### Activity 1

#### Low Frequency

1- Set the frequency and amplitude in its low mode (less than half). Keep the simulation on the *Side View*. Observe the produced waves.

2- Now, change it to *Top View*. Take a screenshot from the page or the wave pattern on your device.

- a) On the screenshot, Show the wavelength of the wave (on the top view).
- b) Measure the wavelength by using the tape meter in the simulation.

c) Compare the frequency and wavelength. Investigate wave behaviours.

#### High Frequency

1- Set the frequency and amplitude on max. Keep the simulation on the *Side View*. Observe the produced waves. Take a screenshot and show the wavelength of the waves by drawing a line.

