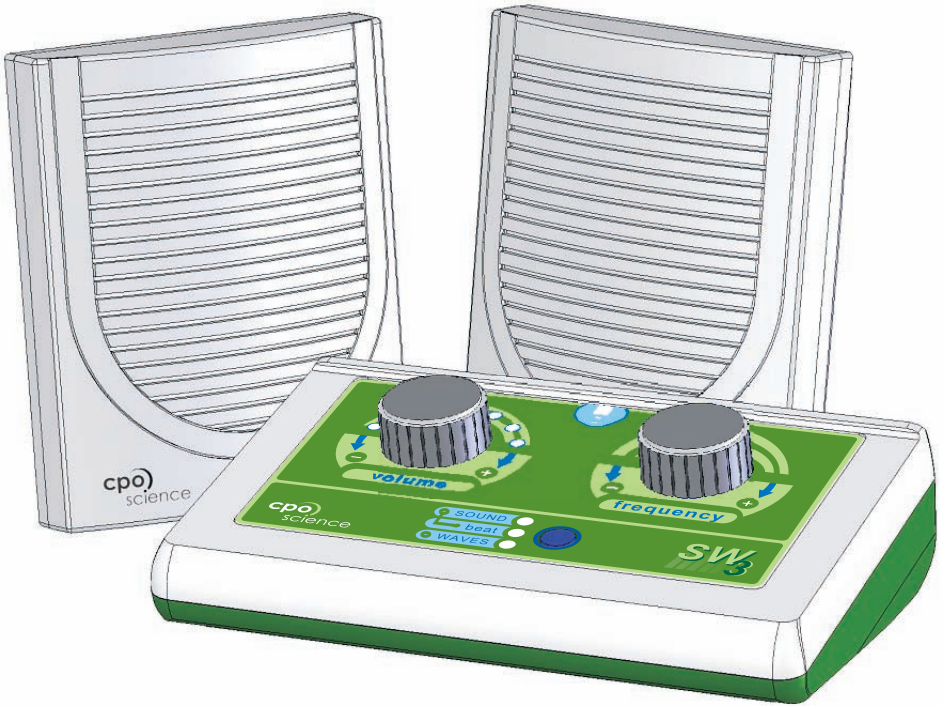
Sound & Waves

Sound & Waves Machine
User's Guide



Introduction

NEW! The Sound & Waves Machine has been newly redesigned. The latest console, the SW3, has a fresh new look with a built-in stand for easier viewing. The SW3's electronics have been completely reengineered for improved reliability. Also new to the Sound & Waves Machine is the addition of beat mode. Beat mode can now be performed with a single Sound & Waves setup.

The Sound & Waves Machine is a versatile system for exploring the phenomena of sound, waves and resonance. The wiggler generates standing waves on an elastic string in a clear, visual way. Students can derive the mathematical relationship between frequency and wavelength for a given system. Attach the speakers, and students can explore sound frequency, beats and wave interference.

Parts Checklist

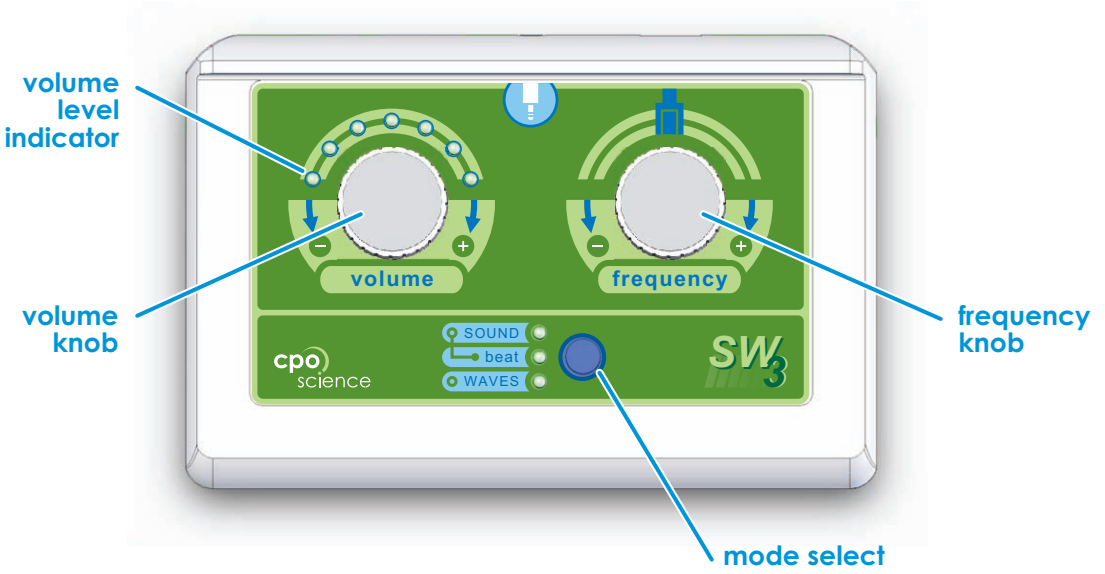
The following items are provided with the Sound & Waves Machine:

- Sound & Waves console
- fiddlehead
- wiggler
- black stereo cable (phono cable)
- elastic cord
- speakers (1 pair) with cord

In addition, you will need these items:

- Physics Stand, assembled
- CPO Timer with supplied power transformer
- timer phone cord
- black knobs (2), in accessory bag

Understanding the Console



1. Mode Selection

The Sound & Waves console is used to control three different modes: Sound, Beat & Waves (wiggler). When the unit is turned on, it starts in sound mode.

From sound mode, **briefly press** the button to switch the unit to beat mode. Once in beat mode, pressing the button returns the unit to sound mode.

From sound mode, **press and hold** the button to switch the unit to wave mode. Once in wave mode, pressing the button returns the unit to sound mode.

2. Frequency Control

Rotate the frequency control knob clockwise to increase the frequency and counter-clockwise to decrease the frequency.

3. Volume Control

Rotate the volume control knob clockwise to increase the volume and counter-clockwise to reduce the volume. The relative volume level is indicated by the lights above the volume knob.

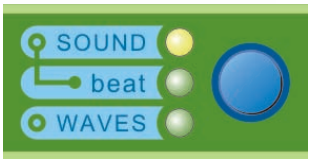
Using Sound Mode

To use the Sound & Waves Machine in sound mode, you will need the SW3 console, Timer console, speakers, a timer phone cord and the CPO power transformer.

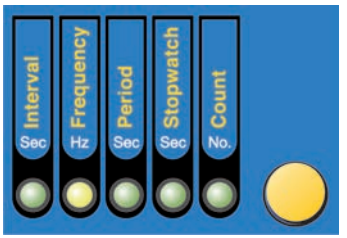
Connect the end of the cord from the speakers into the round jack on the Sound & Waves console.

Next, connect the Sound & Waves console to the timer using the phone cord. Plug one end of the phone cord into slot **A** on the timer and the other end into the square jack on the SW3 console. Make sure that the **A** light is lit on the timer.

Set the Sound & Waves console to sound mode by pressing the mode button on the Sound & Waves console until the light next to "SOUND" is illuminated.

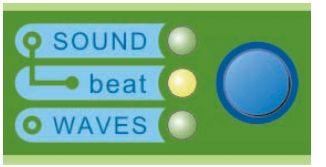


Set the CPO Timer to frequency mode by pressing the mode button on the timer until the light under "Frequency" is illuminated. The number displayed on the timer is sound frequency in hertz (Hz).



Using Beat Mode

Beat mode is a part of sound mode. When studying beats, you will start in sound mode. The frequency shown on the timer display when the SOUND light is lit is the **base frequency**, or **frequency #1**. Write down this number before switching modes.



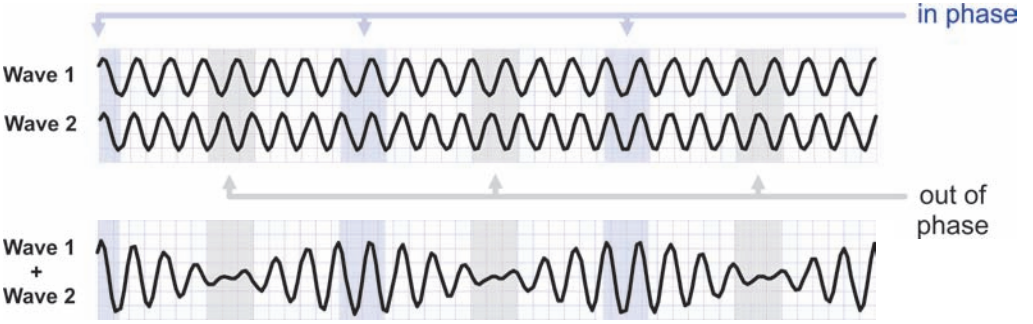
Switch the unit from sound mode to beat mode by pressing the mode button briefly. The light next to "beat" will illuminate, signaling the unit is in beat mode.

In beat mode, turning the frequency knob changes the sound frequency of the second speaker from the base frequency to a new frequency, **frequency #2**. This frequency is now displayed on the timer. The first speaker continues to play the base frequency. While the beat mode light is on you can continue to adjust frequency #2.

From beat mode, press the mode button to return the unit to sound mode. The light next to "SOUND" will light. Leaving beat mode effectively resets the console. The original base frequency is displayed and both speakers play the base frequency.

Understanding Beats

In beat mode, two different sound waves are present, one on each speaker. These sound waves have frequencies that are close, but not exactly the same. The phases of the waves overlap, changing the loudness of sound so that it seems to beat. When the waves are in phase, they combine to create a louder sound. When the waves are out of phase, the waves cancel each other out, creating a quieter sound. This is shown below.



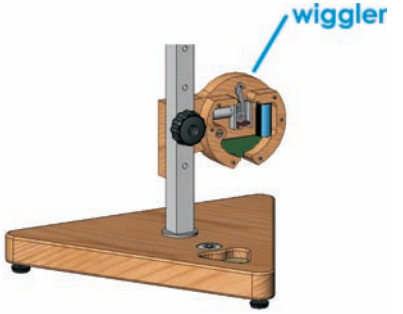
The **beat frequency** is the difference between the frequencies of the two waves. To find the beat frequency, you must subtract the frequency shown on the timer when in beat mode from the base frequency.

Using Wave Mode

To use the Sound & Waves Machine in wave mode, you will need the SW3 console, Timer console, black stereo cable, timer phone cord, CPO power transformer, two black knobs, a Physics Stand, wiggler, fiddlehead, and the elastic cord.

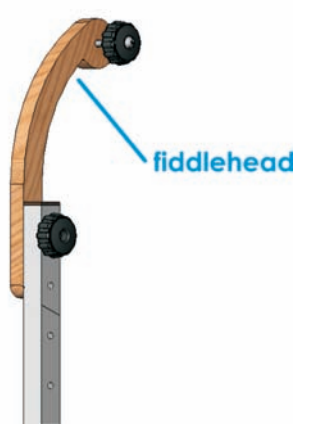
1. Attaching the Wiggler

Attach the wiggler by placing the threaded rod and peg through the bottom two holes of the Physics Stand. Secure the wiggler to the threaded rod with a black knob.



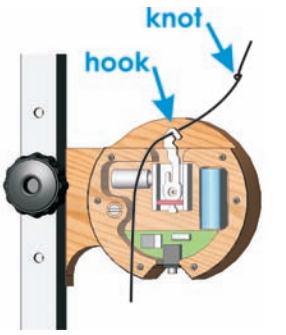
2. Attaching the Fiddlehead

Attach the fiddlehead by placing the threaded rod and peg on the head through the top two holes on the Physics Stand. Secure with a black knob. Be sure the black knobs for the wiggler and fiddlehead are on the same side of the physics pole. The top of the fiddlehead will be higher than the Physics Stand when it is attached.

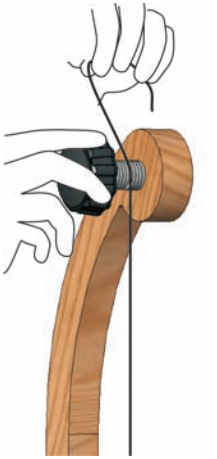


3. Attaching the String

The wiggler arm is a thin metal strip with a hoked end that protrudes from the wiggler about 2cm. If the string is not already attached to the wiggler, locate the hook in the wiggler arm and thread the elastic string through it. Knot the string at the end. This knot will create a stop so that the string can be pulled tight.



3. Attaching the String (continued)



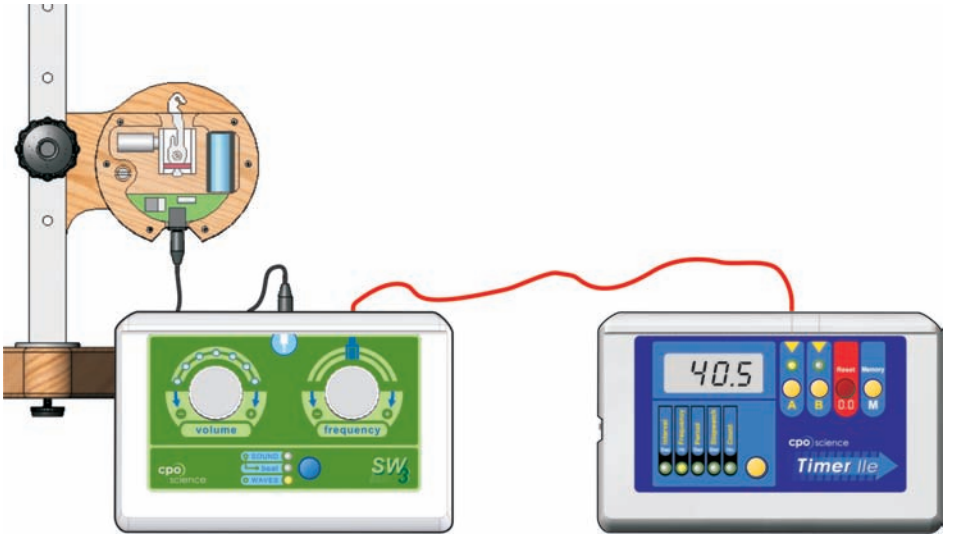
Next, attach the free end of the string to the fiddlehead by pulling it to the top knob on the fiddlehead. At this point there should be no slack in the string. Now tighten the string by stretching it a little (about 10cm). A tighter string will resonate at higher frequencies.

Slide the string between two of the washers behind the knob. Lightly tighten the knob to secure the string.

Note: The string from the wiggler to the fiddlehead is one meter long.

4. Connecting the Console

Connect the black stereo cable into the bottom of the wiggler. Connect the other end of the black stereo cable into the round jack on the Sound & Waves console.



5. Connecting the Timer

Use the timer only with the CPO power transformer (not pictured). Turn on the timer and set it to frequency mode. The light under “Frequency” will illuminate. Plug one end of the phone cord into slot **A** on the timer and the other end into the square jack on the Sound & Waves console. Make sure that the **A** light is lit on the timer. Set the Sound & Waves console to wave mode, illuminating the light next to “WAVES”.

Specifications

Speakers
Normal Impedance: 8 ohms
Frequency Response: 100 - 15K Hz

Sound & Waves Console
Frequency Range: 0.1 - 20K Hz
Accurate quartz crystal oscillator

Power Transformer
Input: 120V, 60Hz, 8W
Output: 9V DC, 500mA
Polarity: Center positive

ALWAYS operate the CPO Timer with the CPO power transformer for sound and wave experiments.

Additional Information

For activities, refer to the *Sound & Waves Curriculum Resource Guide* or *Teacher's Guide*.

For technical Assistance, please call 1-866-588-6951. Or visit us online at www.cposcience.com.

CPO Science warranties this instrument against defects in materials and workmanship for a period of one year. Repair and/or replacement parts can be obtained from CPO Science by calling 1-866-588-6951.